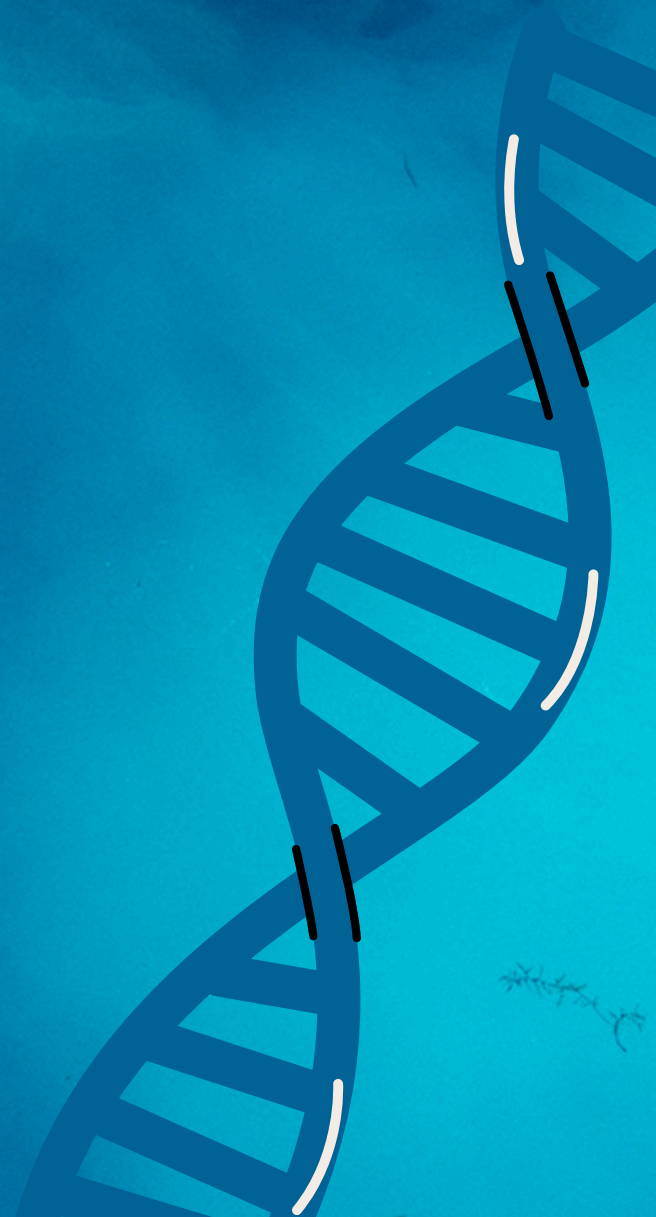
KERALA
BIOTECHNOLOGY
POLICY
2026



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Kerala Biotechnology Policy 2026

1. PREAMBLE

Biotechnology has emerged as a transformative driver of innovation with significant implications for healthcare, agriculture, environmental sustainability, and economic development. Recognizing its potential, the Government of Kerala views biotechnology as a key strategic sector that can enhance the quality of life of its people while supporting long-term, knowledge-driven economic growth.

Kerala's strong foundations in education, public healthcare, biodiversity, and scientific research provide a favourable environment for the growth of biotechnology. Over the years, the State has made steady progress through the establishment of research institutions, capacity-building initiatives, and the emergence of a growing startup ecosystem. At the same time, rapid global advancements in life sciences, genomics, biomanufacturing, and digital biology call for a renewed policy approach that encourages innovation, strengthens collaboration, and accelerates the translation of research into practical applications.

The Kerala Biotechnology Policy shall create an enabling ecosystem that brings together research excellence, industry participation, skilled human resources, and responsible governance. The policy places emphasis on the sustainable use of biological resources, ethical and inclusive innovation, and equitable societal benefits, while positioning Kerala as a nationally important and globally connected biotechnology hub

1.1 Introduction & Rationale

Biotechnology has progressed from being primarily a research-oriented field to becoming a significant driver of economic growth and societal advancement worldwide. Developments in areas such as genomics, synthetic biology, bioinformatics, precision medicine, and industrial biotechnology are reshaping production systems, improving healthcare delivery, and supporting sustainable environmental management.

Kerala's development priorities — including strengthening public health systems, promoting climate-resilient agriculture, harnessing marine resources, and advancing sustainable industries — closely align with the expanding applications of biotechnology. At the same

time, emerging opportunities in biomanufacturing, diagnostics, nutraceuticals, and digital health are creating new pathways for entrepreneurship, innovation, and skilled employment.

While the State has strong academic and research capabilities, challenges remain in translating scientific research into commercially viable products and enterprises. Gaps in shared infrastructure, regulatory processes, industry linkages, and workforce readiness underline the need for a more coordinated and enabling policy framework.

The revised policy therefore shall bridge the gap between research and industry, strengthen innovation and commercialization pathways, and create a supportive ecosystem that shall promote startups, institutions, and investors to actively participate in the growth of Kerala's biotechnology sector.

1.2 Kerala Biotechnology Landscape

Kerala has developed a growing biotechnology ecosystem supported by research institutions, universities, healthcare facilities, and specialized technology centres. Institutions such as research laboratories, medical technology centres, and life science parks have contributed significantly to scientific capacity building and innovation.

The State's strengths include:

- A strong public health system and clinical research capability
- Rich biodiversity and traditional knowledge resources
- Expanding higher education and scientific manpower
- Emerging biotechnology startups and incubation ecosystems
- Established science and technology governance structures

Key sectors demonstrating potential growth include healthcare biotechnology, agriculture and animal biotechnology, marine biotechnology, nutraceuticals and Ayurveda-based innovations, medical devices, and data-driven biotechnology applications.

The initiatives such as Life Science / biotechnology parks, innovation programmes, and collaborative research platforms have strengthened the ecosystem, though further integration and scaling are required to achieve global competitiveness.

1.3 Need for Policy Revision

Since the earlier biotechnology policy framework, the global biotechnology landscape has undergone rapid transformation driven by advances in genomics, artificial intelligence, bioengineering, and biomanufacturing. New regulatory requirements, innovation models, and commercialization pathways have also emerged.

Stakeholder consultations conducted across academia, industry, startups, healthcare institutions, and government agencies identified several areas requiring policy revision:

- Need for stronger industry–academia collaboration
- Enhancement of shared infrastructure and translational facilities
- Simplification of regulatory and approval mechanisms
- Development of industry-ready skilled manpower
- Support systems for startups and early-stage innovators
- Improved data governance and biotechnology analytics systems
- Clear policy positions on technologies such as GM crops and synthetic biology

The revised policy seeks to address these evolving needs through an integrated and coordinated approach that aligns research, innovation, infrastructure development, governance mechanisms, and societal outcomes.

1.4 Policy Vision and Strategic Context

The Kerala Biotechnology Policy is aligned with national science and technology priorities and emerging global bioeconomy trends. The policy supports India's biotechnology growth missions and aligns with national initiatives such as BioE3 (Biotechnology for Economy,

Environment and Employment), digital health transformation, and sustainable development goals.

The strategic context of the policy focuses on:

- Building a resilient and innovation-driven bioeconomy
- Promoting sustainable utilization of biological resources
- Strengthening biotechnology manufacturing and value chains
- Encouraging entrepreneurship and private sector participation
- Leveraging data science and artificial intelligence in biotechnology
- Ensuring ethical governance, biosafety, and inclusiveness

Through coordinated implementation mechanisms and institutional strengthening, the policy aims to transform Kerala into a leading biotechnology destination contributing to economic growth, environmental sustainability, and societal well-being.

2. VISION, MISSION & OBJECTIVES

The Kerala Biotechnology Policy establishes a clear direction for strengthening the State's biotechnology ecosystem through innovation, sustainability, and inclusive growth. The Vision and Mission outlined below provide the guiding framework for policy implementation, institutional development, and strategic investments in biotechnology.

2.1. Vision

To position Kerala as a globally connected biotechnology and bioeconomy hub driven by innovation, sustainability, and responsible use of its biological resources.

2.2. Mission

To build a dynamic and collaborative biotechnology ecosystem in Kerala by strengthening research excellence, developing skilled human resources, promoting innovation and entrepreneurship, enabling sustainable biomanufacturing, and fostering partnerships among academia, industry, and government to deliver socially relevant and economically impactful biotechnology solutions.

2.3. Core Policy Objectives

The Kerala Biotechnology Policy aims to strengthen the State's biotechnology ecosystem through the following core objectives:

1) Strengthen biotechnology research and innovation aligned with the State's priority sectors.
2) Accelerate translation of research into products and enterprises through industry collaboration and commercialization support.
3) Develop a skilled and future-ready workforce through education, training, and industry-linked capacity building.

4) Promote biotechnology startups and industry growth by enabling infrastructure, funding access, and regulatory facilitation.
5) Build world-class biotechnology infrastructure and biomanufacturing capabilities to support innovation and scale-up.
6) Ensure sustainable, ethical, and inclusive biotechnology development while strengthening national and global partnerships.

2.4. Scope of the Policy

The Kerala Biotechnology Policy provides a comprehensive framework to promote biotechnology research, innovation, industry development, and responsible application of biotechnology across priority sectors of the State. The policy covers the entire biotechnology ecosystem, from knowledge creation and skill development to product commercialization and societal deployment.

The policy applies to universities, research institutions, startups, industries, MSMEs, incubators, innovation centres, and all public and private stakeholders engaged in biotechnology activities within Kerala.

2.5. Definitions

For the purposes of this Policy, unless the context otherwise requires:

2.5.1. Biotechnology

The application of biological systems, living organisms, or their derivatives to develop or modify products, processes, or services for specific industrial, healthcare, agricultural, environmental, or societal purposes.

2.5.2 Bioeconomy

Economic activities derived from the sustainable use of biological resources, biotechnology innovation, and bio-based products and services.

2.5.3 Biomanufacturing

The use of biological systems, cells, or biomolecular processes for large-scale production of pharmaceuticals, biologics, enzymes, biomaterials, and other bio-based products.

2.5.4 Biotech Park

A designated cluster providing infrastructure, laboratories, incubation facilities, and shared services to support biotechnology research, innovation, and industrial activities.

2.5.5 Startup (Biotechnology Startup)

An entity engaged in innovation, development, deployment, or commercialization of biotechnology-based products, processes, or services, recognized under applicable Government of India or State policies.

2.5.6 Translational Research

Research activities aimed at converting scientific discoveries into practical applications, technologies, or commercially viable products.

2.5.7 Biosafety

Measures, regulations, and practices adopted to ensure safe handling, containment, and use of biological agents and biotechnology products to protect human health and the environment.

2.5.8 Biosecurity

Institutional and regulatory measures implemented to prevent misuse, unauthorized access, or unintended release of biological materials and related technologies.

2.5.9 Public–Private Partnership (PPP)

A collaborative arrangement between government agencies and private entities for financing, developing, or operating biotechnology infrastructure, services, or programmes.

2.5.10 Incubation Centre

A facility providing mentorship, infrastructure, technical support, and business development assistance to startups and early-stage biotechnology enterprises.

2.5.11 Shared Core Facilities

Common research infrastructure and high-end equipment accessible to multiple institutions, researchers, startups, or industries.

2.5.12 Biobank

A structured repository for collection, storage, management, and distribution of biological samples and associated data for research and clinical purposes.

2.5.13 Data Repository

A secure digital platform for storage, management, and controlled sharing of biological and research data generated through biotechnology activities.

2.5.14 One Health Approach

An integrated approach recognizing the interconnection between human health, animal health, and environmental health in policy and research interventions.

2.5.15 Section 8 Company

A not-for-profit company established under Section 8 of the Companies Act, 2013, formed to implement biotechnology programmes, manage funds, and support ecosystem development.

3. GOVERNANCE & INSTITUTIONAL FRAMEWORK

The implementation of the Kerala Biotechnology Policy shall be supported through a structured governance framework to ensure coordinated decision-making, effective implementation, and stakeholder participation across the biotechnology ecosystem.

3.1. Kerala Biotechnology Board (KBB)

1) The Kerala Biotechnology Board shall function as the apex policy and strategic oversight body for biotechnology development in the State.
2) The Board shall be chaired by the Hon'ble Chief Minister of Kerala.
3) The Board shall consist of representatives from Government, academia, research institutions, industry, and other relevant sectors to ensure balanced representation and expert guidance.
4) The Board shall provide overall policy direction, approve major strategic initiatives, and review progress of biotechnology programmes.
5) The Government shall nominate additional members or invite special representatives based on emerging priorities of the biotechnology sector.
6) The Board shall facilitate interdepartmental coordination and alignment with State development priorities.

3.2. Kerala Biotechnology Commission (KBC)

1) The Kerala Biotechnology Commission shall serve as the nodal agency for implementation and coordination of biotechnology initiatives under this Policy.
2) The KBC shall consist of representatives from Government, academia, research institutions, industry, and relevant experts to ensure balanced representation and effective implementation guidance.
3) KBC shall design, implement, monitor, and evaluate programmes and schemes aligned with policy objectives.

4) KBC shall coordinate with State departments, national agencies, research institutions, and industry stakeholders.
5) KBC shall facilitate innovation promotion, startup support, infrastructure development, and regulatory coordination within the biotechnology sector.
6) KBC shall establish monitoring mechanisms and periodically report progress to the Kerala Biotechnology Board.

3.3. Establishing Section 8 Company for Biotechnology Implementation

1) The Government shall establish a Section 8 Company under the Companies Act, 2013, to support operational implementation of biotechnology programmes and ecosystem initiatives.
2) The Section 8 Company shall function under the overall governance framework of the Kerala Biotechnology Board and Kerala Biotechnology Commission.
3) The entity shall facilitate programme execution, fund management, partnership development, and project implementation with operational flexibility.
4) The Board of Directors shall include representatives from Government, industry, academia, and subject experts.
5) The Company shall operate with defined financial management, transparency, and accountability mechanisms in accordance with applicable rules.

3.4. Sectoral Councils

The Government shall constitute Sectoral Councils under the KBC for priority domains including:

1) Human Resource Development
2) Healthcare and Medical Biotechnology
3) Agricultural and Animal Biotechnology
4) Marine Biotechnology
5) Industrial and Environmental Biotechnology

Each Sectoral Council shall:

1) Identify priority research and innovation areas

2) Recommend targeted interventions and programs
3) Facilitate collaboration among institutions and industry stakeholders
4) Advise on regulatory and infrastructure requirements within the sector

The Government shall encourage the formation of regional biotechnology clusters to strengthen local innovation ecosystems.

The Kerala Biotechnology Board shall provide strategic oversight, while the Kerala Biotechnology Commission shall function as the nodal implementation and coordination agency. Programme execution may be supported through the proposed Section 8 Company in collaboration with relevant departments and institutional partners.

4. STRATEGIC PILLARS

The Kerala Biotechnology Policy will be implemented through strategic pillars that strengthen research, infrastructure, human resources, industry growth, sustainability, and governance, ensuring coordinated action and long-term sectoral development.

4.1. R&D Excellence & Innovation

The Policy shall promote high-quality research and innovation across priority biotechnology domains by strengthening scientific capabilities and encouraging translational outcomes.

Key focus areas include:

1) The Government shall promote high-quality basic, applied, and translational research in priority biotechnology domains.
2) Research efforts shall be aligned with State-specific strengths in healthcare, agriculture, marine resources, Ayurveda, environmental sustainability, and industrial biotechnology.
3) Dedicated support shall be provided for interdisciplinary and multi-institutional research programs.
4) Translational research shall be prioritized to ensure that laboratory discoveries are converted into deployable technologies and products.
5) Mechanisms shall be established to strengthen technology transfer, intellectual property management, and commercialization pathways.

4.2. Infrastructure & Biomanufacturing

The Policy shall strengthen biotechnology infrastructure to support research excellence, translational innovation, and biomanufacturing growth. Emphasis shall be placed on developing shared core facilities, pilot-scale platforms, and innovation clusters that enable efficient resource utilization and industry participation. Infrastructure development will be aligned with startup needs, sectoral priorities, and emerging technology domains to ensure scalable and globally competitive biotechnology capabilities.

Detailed infrastructure components, facility frameworks, and institutional arrangements are elaborated in the Biotechnology Infrastructure Framework (Section 7) of this Policy.

4.3. Human Resource Development & Skill Ecosystem

The Policy shall promote the development of a skilled and future-ready biotechnology workforce aligned with evolving industry, research, and innovation requirements. Human Resource Development will focus on strengthening biotechnology education, enhancing practical training exposure, building faculty capacity, supporting advanced research talent, and integrating emerging technologies into skill development pathways. The pillar emphasizes stronger academia–industry linkages to improve employability and support innovation-driven growth within the State's biotechnology ecosystem.

The Human Resource Development pillar establishes the strategic direction for building a skilled biotechnology workforce aligned with research, industry, and innovation needs. Detailed programmes, institutional mechanisms, and implementation strategies relating to skill development, training, fellowships, and industry engagement are presented under the Human Resource Development Framework (Section 8) of this Policy.

4.4. Industry Promotion & Startup Ecosystem

The Policy shall create a supportive environment for biotechnology enterprises, startups, and industry participation through coordinated efforts of Kerala Biotechnology Commission, Kerala State Startup Mission, and Kerala State Industrial Development Corporation.

Key interventions include:

1) Strengthening single-window facilitation mechanisms for biotechnology enterprises
2) Supporting incubation centres with wet-lab and shared infrastructure facilities
3) Providing startup incentives, mentoring, and market linkage support
4) Facilitating technology transfer and commercialization pathways
5) Promoting Public–Private Partnerships and collaborative innovation models

6) Supporting Contract Research Organizations (CROs) and clinical research ecosystems
7) Encouraging investment through venture funding and international partnerships

4.5. Sustainable & Rural Biotechnology

The Policy shall promote biotechnology solutions that support sustainable development and inclusive growth across rural and coastal regions.

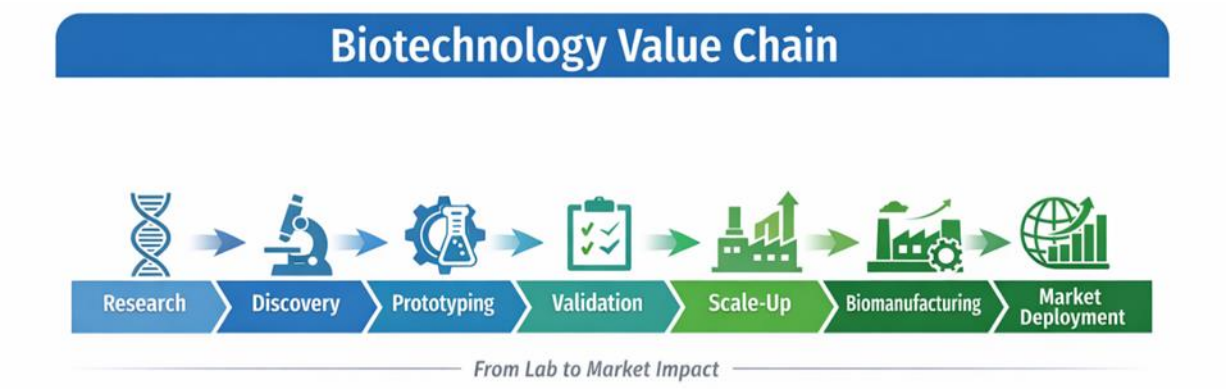
Key areas include:

1) Biotechnology interventions for climate-resilient agriculture and soil health
2) Sustainable aquaculture and marine biotechnology applications
3) Community-level biotechnology solutions for healthcare and environmental management
4) Promotion of bio-based rural enterprises and farmer-linked biotechnology initiatives
5) Development of nutraceuticals and value-added products from local bioresources
6) Deployment of mobile biotechnology outreach and training programmes

4.6. Regulatory Facilitation & Biosafety Assurance

The Policy shall promote a transparent, efficient, and science-based regulatory environment that enables innovation while ensuring protection of public health, biodiversity, and environmental sustainability. Regulatory facilitation shall prioritize ease of doing research and business, responsible innovation, biosafety compliance, and ethical governance aligned with national standards.

Detailed provisions relating to single-window clearances, time-bound approvals, data governance, biobanks, and One Health surveillance are provided under the Regulatory & Biosafety Framework (Section 11) of this Policy.


Biotechnology Value Chain
Research
Discovery
Prototyping
Validation
Scale-Up
Biomanufacturing
Market Deployment
From Lab to Market Impact

5. SECTOR-SPECIFIC STRATEGIES

The Kerala Biotechnology Policy 2026 recognizes the importance of sector-specific interventions in translating biotechnology advancements into tangible economic, environmental, and societal outcomes. The Policy therefore focuses on priority sectors—agriculture, animal and veterinary health, marine and blue economy, healthcare, and Ayurveda, natural products, and nutraceuticals—where biotechnology can address Kerala's development needs while building on the State's existing strengths and opportunities for sustainable and inclusive growth.

This section outlines the strategic priorities for these sectors. Cross-cutting technology platforms, infrastructure systems, human resource initiatives, and regulatory mechanisms that enable sectoral development are detailed in Sections 6, 7, 8, and 11 of this Policy.

In addition, the Policy recognizes **Environmental Biotechnology and Bioprocess Technology** as critical cross-cutting domains that strengthen sustainable development and industrial scalability across sectors. Environmental Biotechnology shall support waste management, pollution mitigation, resource recovery, and ecosystem restoration, contributing to circular bioeconomy and climate resilience goals. Bioprocess Technology shall enable efficient scale-up, value addition, and commercial production of bio-based products through advanced fermentation, downstream processing, and manufacturing platforms. These domains shall be integrated across sectoral strategies and aligned with infrastructure, technology, and regulatory frameworks outlined in subsequent sections of this Policy.

5.1 Agriculture Biotechnology

Kerala, with a geographical area of approximately 38,863 km², sustains a unique agriculture system dominated by smallholder and high-value crop production, with nearly one-third of the State's land area engaged in agriculture and allied activities. The sector plays a critical role in livelihood security, supporting a large rural population through plantation crops, spices, horticulture, and integrated farming systems. However, increasing climate variability, recurrent pest and disease outbreaks, declining soil productivity, and constraints arising from

fragmented landholdings necessitate a transition towards climate-resilient, technology-driven agricultural systems. Changing rainfall patterns and rising temperature trends further underscore the need for scientific interventions that enhance productivity while conserving natural resources. Kerala's research institutions and agricultural universities have generated region-specific innovations, including improved crop varieties, tissue culture propagation systems, and sustainable bio-input technologies suited to tropical agro-ecosystems. Leveraging existing capabilities,, the State shall accelerate the deployment of advanced biotechnology approaches to address biotic and abiotic stresses impacting agricultural growth and quality, leveraging genomics, phenomics, genome editing, micropropagation, microbial bio-inputs, and precision agriculture technologies. These interventions shall support sustainable intensification, improve farm incomes, enhance resilience to climate change, and position Kerala as a model for knowledge-driven, sustainable agricultural transformation.

Agriculture biotechnology shall be promoted as a strategic priority to enhance productivity, sustainability, climate resilience, and value addition within Kerala's agriculture sector. The Policy recognizes that strengthening scientific infrastructure, enabling technology adoption, and improving research-to-field translation are essential for addressing emerging agricultural challenges, including climate variability, pest and disease pressures, and resource constraints.

5.1.1 Sectoral Context

Kerala's agricultural biotechnology ecosystem presently faces limitations in advanced research infrastructure, particularly in genomics, molecular breeding, and high-throughput data analysis. Adoption of modern technologies such as precision agriculture, genome editing, and smart farming systems remains limited, while weak linkages among research institutions, industry, and farming communities constrain effective technology transfer. The Policy shall therefore strengthen translational research frameworks and commercialization pathways to ensure timely delivery of biotechnology innovations to farmers and agri-based enterprises. Introduction of genetically modified (GM) and genome-edited crops shall be considered based on comprehensive biosafety evaluation and in alignment with national regulatory frameworks to enhance crop resilience against climate change, pests, and diseases.

5.1.2 Research and Innovation Priorities

The Government shall promote research programmes focusing on:

- Development of climate-resilient and pest- and disease-resistant crop varieties suited to Kerala's agroclimatic conditions
- Plant genomics, epigenomics, and molecular breeding for crop improvement and conservation
- Transgene-free genome editing technologies for development of improved non-GMO crop varieties
- Promotion of biofertilizers, biopesticides, and biostimulants to support sustainable agriculture
- Post-harvest and storage technologies to reduce losses and improve quality and shelf life
- Discovery and sustainable utilization of plant bioresources and biomolecules of agricultural and pharmaceutical importance
- Molecular diagnostic tools for early detection of plant pests and diseases
- Artificial intelligence–enabled precision agriculture solutions

A Centre for Artificial Intelligence in Agriculture shall be established to integrate agricultural datasets and develop smart tools for pest surveillance, crop health monitoring, weather prediction, nutrient management, irrigation scheduling, and quality assessment of high-value crops.

5.1.3 Infrastructure Development

The Policy shall strengthen agricultural biotechnology infrastructure through:

- Establishment of central facilities for plant genomics and molecular breeding research
- Creation of a State-level phenomics facility for advanced crop characterization
- Development of seed production and quality testing laboratories
- Establishment of pilot-scale fermentation and processing facilities for bio-input production

- Development of regional molecular diagnostic laboratories for plant health surveillance
- Establishment of demonstration farms and technology validation centres

Infrastructure shall be accessible to academic institutions, startups, MSMEs, and farmer-oriented enterprises.

5.1.4 Capacity Building and Skill Development

Capacity-building initiatives shall focus on improving biotechnology literacy and field-level adoption through:

- Farmer Field Schools and community-based biotechnology awareness programmes
- Skill-oriented training programmes for farmers, students, and extension personnel
- Student internships and field exposure programmes in crop biotechnology and precision agriculture
- Laboratory-based training integrated with field demonstrations
- Faculty development programmes in genomics, molecular breeding, and advanced biotechnology tools

5.1.5 Policy and Regulatory Support

The Government shall establish enabling policy mechanisms to accelerate agricultural biotechnology adoption, including:

- Targeted subsidies for bio-inputs such as biofertilizers, biopesticides, and biostimulants
- Development of crop and gene-specific biosafety evaluation guidelines for GM and genome-edited crops
- Fast-track regulatory facilitation for biotechnology-based agricultural innovations while ensuring biosafety compliance
- Promotion of translational research and industry-linked R&D clusters

All biotechnology interventions shall adhere to environmental safety, biodiversity conservation, and ethical governance principles.

5.1.6 Funding and Innovation Support

The Policy shall address funding gaps through:

- Dedicated grant schemes for translational agricultural biotechnology research
- Innovation funds supporting farmer-led biotechnology solutions
- Expanded fellowships for students and researchers in agricultural biotechnology
- Entrepreneurship support mechanisms for agri-biotech startups and MSMEs
- Funding support for commercialization of research outcomes

Funding mechanisms shall prioritize outcome-oriented research with measurable field impact.

5.1.7 Strategic Research Initiatives

To support Kerala's transition toward sustainable and organic agriculture, the Policy shall promote:

- Establishment of dedicated facilities for development and formulation of biopesticides
- Research on next-generation molecular biopesticides, including RNAi-based technologies
- State-supported facilitation for toxicological evaluation and regulatory registration of biopesticides
- Deep genomic and epigenomic studies to strengthen crop diversity conservation and improvement
- Development of regionally distributed plant diagnostic facilities across the State

Collaborative programmes involving State and national institutions shall be encouraged to accelerate innovation and commercialization.

5.1.8 Institutional Strengthening and Governance

The Kerala Biotechnology Commission (KBC) shall promote coordinated research clusters and collaborative networks among agricultural universities, research institutions, and

industry partners to enhance efficiency, resource sharing, and technology deployment. Greater institutional coordination shall support translational research, entrepreneurship, and innovation-driven agricultural development.

5.1.9 Sustainable Utilization of Bioresources

The Policy shall prioritize basic and applied research for sustainable utilization of Kerala's biological resources, supporting identification, validation, and commercialization of high-value biomolecules while ensuring ecological sustainability and equitable benefit sharing.

Policy Position: Genetically Modified and Genome-Edited Crops

The Kerala Biotechnology Policy recognizes the potential of genetically modified (GM) and genome-edited crops in improving agricultural resilience, productivity, and sustainability. The State shall adopt a science-based and precautionary approach aligned with Government of India biosafety regulations.

Research and confined field trials shall be supported in approved institutions following established biosafety protocols. Deployment of such technologies shall be based on crop- and gene-specific biosafety evaluation, environmental safeguards, and public health considerations.

Commercial cultivation shall be permitted only upon approval from competent national regulatory authorities.

The Policy promotes informed stakeholder engagement and public awareness to ensure transparency while balancing technological advancement with biodiversity conservation and environmental safety.

5.2 Animal & Veterinary Biotechnology

Kerala's livestock and animal husbandry sector plays a vital role in rural livelihoods, nutritional security, and the State's agricultural economy, supporting a large number of small and marginal farmers. The sector is strengthened by a well-established dairy cooperative network and a growing demand for milk, meat, and eggs, with dairy farming serving as an important income source for rural households, particularly women-led self-help groups. However, increasing risks from zoonotic diseases, climate stress, antimicrobial resistance, and productivity constraints necessitate science-based interventions to ensure sustainable

growth. Veterinary universities and research institutions have established capabilities in advanced diagnostics, breeding technologies, and disease surveillance systems suited to tropical conditions. To advance sectoral development,, Kerala shall promote veterinary and animal biotechnology applications including genomics-assisted breeding, molecular diagnostics, vaccine development, reproductive biotechnologies, microbiome research, and precision livestock management to improve animal health and productivity. These interventions shall strengthen biosecurity, enhance value addition in animal products, support the One Health framework, and enable sustainable and resilient livestock systems.

Animal and veterinary biotechnology shall be promoted to strengthen livestock health, productivity, disease surveillance, and biosecurity systems in Kerala. The Policy recognizes the growing importance of biotechnology interventions in addressing zoonotic diseases, antimicrobial resistance, food security, and sustainable livestock development.

5.2.1 Sectoral Context

The animal biotechnology ecosystem in Kerala faces gaps in veterinary disease surveillance, diagnostics, and advanced research infrastructure. Existing laboratories require strengthening to effectively address emerging zoonotic and infectious diseases, and higher biosafety containment facilities remain underutilized or insufficiently operational. The availability of trained biotechnology specialists in animal health research is limited, constraining innovation and translational outcomes.

Adoption of reproductive biotechnology and advanced breeding technologies among livestock farmers also remains limited. The Policy therefore shall integrate biotechnology tools into animal health, breeding, and production systems through strengthened institutional collaboration and capacity development.

5.2.2 Research and Innovation Priorities

The Government shall promote research focused on:

- Improvement of livestock genetics using molecular and genomic tools to enhance productivity and disease resistance

- Development of rapid diagnostics, vaccines, and therapeutics for major livestock diseases
- Recombinant protein-based vaccines and next-generation veterinary biologics
- Marker-assisted diagnostics for identifying genetic predisposition to diseases, including mastitis resistance and other production traits
- Development of monoclonal antibodies for diagnostic and therapeutic applications, particularly for rabies and zoonotic diseases
- Biotechnology interventions for fodder improvement and feed efficiency
- Precision livestock farming supported by biotechnology-based monitoring systems
- Reproductive biotechnology including artificial insemination, embryo transfer, in vitro fertilization, and use of sexed semen

5.2.3 Infrastructure Development

The Policy shall strengthen veterinary biotechnology infrastructure through:

- Establishment of dedicated veterinary disease diagnostic laboratories across the State
- Creation of vaccine production and validation facilities for recombinant vaccines and diagnostics
- Strengthening veterinary R&D institutions with advanced biotechnology laboratories
- Operationalization of BSL-3 and BSL-4 laboratories at the Institute of Advanced Virology and Bio360 Life Science Park for advanced pathogen research and vaccine development
- Establishment of field-level demonstration and training centres for technology validation and adoption

5.2.4 Capacity Building and Skill Development

Capacity-building programmes shall focus on strengthening human resources across the veterinary ecosystem through:

- Specialized training programmes for veterinarians and livestock keepers in biotechnology applications

- On-farm training in artificial insemination, heat synchronization, pregnancy diagnosis, vaccination, and disease surveillance
- Exposure to emerging tools such as probiotics, feed enzymes, and nutrigenomics-based livestock nutrition
- Community-based breeding programmes involving genomic data collection and farmer participation
- Expansion of professional education and training programmes in animal biotechnology
- Establishment of Centres of Excellence in veterinary biotechnology

Awareness and extension programmes shall promote understanding of biosafety, bioethics, and biotechnology applications among farmers, students, and extension personnel.

5.2.5 Disease Surveillance and One Health Integration

The Policy shall strengthen animal health surveillance systems by:

- Establishing state-supported disease surveillance programmes for early detection and control of emerging diseases
- Integrating zoonotic disease monitoring and antimicrobial resistance surveillance into the Kerala Antimicrobial Resistance Strategic Action Plan (KARSAP)
- Strengthening district-level veterinary laboratories and diagnostic networks
- Promoting coordinated One Health approaches linking human, animal, and environmental health systems

5.2.6 Policy and Regulatory Facilitation

The Government shall establish enabling regulatory frameworks to support innovation in veterinary biotechnology through:

- Fast-track regulatory facilitation for veterinary vaccines, biologics, and diagnostics while ensuring safety and quality standards
- Promotion of public–private partnerships in veterinary biotechnology development
- Support for biotechnology-based veterinary extension models delivering IVF, genomic breeding, and diagnostics at farm level

- Awareness programmes on genome editing technologies and regulatory frameworks governing biotechnology applications

5.2.7 Funding and Innovation Support

To address funding gaps, the Policy shall introduce:

- Dedicated grant schemes for applied and translational research in animal biotechnology
- Annual problem-oriented research funding programmes under KBC
- Innovation funds supporting livestock keepers and community breeding programmes
- Fellowships and research grants to attract and retain skilled professionals in veterinary biotechnology
- Funding mechanisms leveraging public–private partnerships, international collaborations, and Section 8 Company models

5.2.8 Institutional Collaboration and Governance

The Policy shall promote coordinated research consortia involving key institutions such as the Rajiv Gandhi Centre for Biotechnology (RGCB), Kerala Veterinary and Animal Sciences University (KVASU), Institute of Advanced Virology (IAV), Bio360 Life Science Park, and other innovation centres to enable unified research agendas, shared infrastructure utilization, and accelerated translation of research outcomes into field-level applications.

5.3 Marine Biotechnology and Blue Economy

Kerala's extensive coastline and rich marine biodiversity provide significant opportunities to harness biotechnology for sustainable economic growth and improved coastal livelihoods. Marine and coastal ecosystems support fisheries, aquaculture, and allied activities while offering valuable biological resources with applications in healthcare, nutraceuticals, environmental management, and bio-based industries. Increasing challenges such as climate change, marine pollution, and ecosystem degradation highlight the need for science-based and sustainable approaches to marine resource utilization.

In alignment with State priorities, the State shall promote marine biotechnology applications including marine genomics, bioactive compound discovery, seaweed biotechnology, sustainable aquaculture systems, marine microbial research, and bioremediation technologies. Emphasis shall also be placed on developing high-value products such as nutraceuticals, functional foods, and bio-based materials derived from marine resources.

Marine biotechnology initiatives shall support sustainable livelihoods for coastal communities, enhance value addition and entrepreneurship, and promote conservation of marine ecosystems through responsible resource management. These efforts shall also contribute to the One Health framework by integrating environmental monitoring with aquatic animal and human health considerations.

Marine biotechnology and the blue economy shall be promoted as strategic priorities to enable innovation-driven growth, strengthen coastal economies, and ensure sustainable utilization of marine resources.

5.3.1 Sector Context

Kerala's marine and coastal ecosystems offer significant potential for advancing marine biotechnology and supporting blue economy development. However, the sector remains underutilized due to gaps in bioresource mapping, limited databases on marine organisms, and weak linkages between research institutions, industry, and coastal communities. Biotechnology Policy recognizes the need to strengthen research coordination, infrastructure, and technology transfer mechanisms to enable responsible utilization of marine bioresources while promoting livelihood enhancement, environmental sustainability, and value creation.

5.3.2 Priority Research Areas

The Policy shall promote research and innovation in marine biotechnology with emphasis on:

- Development of sustainable aquaculture technologies to enhance productivity while conserving marine ecosystems

- Exploration and utilization of marine bioresources for nutraceuticals, functional foods, and value-added products
- Marine biomedicine and drug discovery, including identification of bioactive compounds from marine organisms
- Application of marine microbes for waste bioremediation and coastal pollution management
- Research on climate-resilient fisheries, ocean health monitoring, and ecosystem sustainability

5.3.3 Infrastructure Development

To strengthen marine biotechnology capabilities, the Policy shall support:

- Establishment of marine biotechnology field stations along Kerala's coastline for research, sampling, and technology demonstration
- Creation of marine bioresource databanks and repositories for systematic documentation and conservation of marine genetic resources
- Development of pilot-scale facilities for aquaculture innovation and bioactive compound extraction
- Establishment of marine waste treatment and bioremediation facilities to promote environmentally sustainable coastal development

5.3.4 Capacity Building and Outreach

The Policy shall promote human resource development through:

- Training programmes for fisherfolk and coastal communities on sustainable aquaculture and marine resource utilization
- Student internships and field-based training in marine biotechnology and bioresource exploration
- Industry–academia collaborative programmes to strengthen technology transfer and innovation
- Skill development initiatives supporting entrepreneurship and employment in marine biotechnology sectors

5.3.5 Policy Support and Regulatory Facilitation

The State shall introduce enabling policy measures to accelerate growth of marine biotechnology, including:

- Targeted incentives for startups developing marine-derived nutraceuticals, bioactive compounds, and aquaculture technologies
- Facilitated and time-bound regulatory pathways for marine biotechnology products in alignment with national regulations
- Strengthening conservation frameworks through biodiversity mapping and responsible utilization of marine genetic resources

5.3.6 Funding and Innovation Support

Recognizing existing financial gaps, the Policy shall provide:

- Dedicated seed funding schemes for marine biotechnology startups and early-stage enterprises
- Grants for exploratory and translational research in marine nutraceuticals, aquaculture biotechnology, and marine biomedicine
- Support mechanisms encouraging commercialization and industry participation

5.3.7 Strategic and Cross-Sectoral Integration

The Policy shall leverage Kerala's biodiversity strengths by promoting:

- Sustainable bioprospecting for high-value biomolecules including nutraceuticals, antimicrobial peptides, and bioactive compounds
- Alignment with national initiatives such as BioE3 to promote circular bioeconomy and green growth
- Inclusion of emerging domains such as biofuels, bioenergy, synthetic biology, and advanced bioinformatics within marine biotechnology innovation pathways

- Transformation of biotechnology parks into biomanufacturing and biofoundry hubs fostering academia–industry collaboration, innovation, and employment generation.

Regulatory Note: Seaweed Cultivation

Seaweed cultivation undertaken for biotechnology and bioeconomy applications shall comply with nationally notified guidelines governing marine and brackish water farming. Activities shall adhere to prescribed standards relating to registration, biosecurity measures, environmental safeguards, approved cultivation practices, and traceability of biological materials to ensure sustainable and responsible utilization of marine bioresources.

Promoting sustainable blue bioeconomy through responsible marine practices.

5.4 Healthcare & Medical Biotechnology

Healthcare and medical biotechnology shall be a priority sector under the Kerala Biotechnology Policy, recognizing its critical role in strengthening public health systems, advancing precision medicine, and supporting the State's growing bioeconomy. Kerala aims to leverage its strong healthcare infrastructure, clinical expertise, and research institutions to develop an integrated biotechnology-driven healthcare ecosystem.

The Policy shall promote the development of advanced diagnostics, therapeutics, biologics, medical technologies, and data-driven healthcare solutions aligned with emerging national and global trends. Emphasis shall be placed on translational research that addresses Kerala's dual burden of communicable and non-communicable diseases, while improving accessibility, affordability, and preventive healthcare delivery.

Key Strategic Focus Areas

1. Priority Healthcare Biotechnology Domains

The Policy shall support research, innovation, and commercialization in:

- Molecular and point-of-care diagnostics, including high-throughput and panel-based testing
- Precision and personalized medicine using genomics and omics technologies
- Vaccines, biologics, and biosimilars

- Cell-based therapies, tissue engineering, and regenerative medicine
- Digital health and AI-enabled clinical decision systems
- Medical devices and biotechnology-enabled MedTech solutions
- Nutritional biotechnology addressing micronutrient deficiencies and lifestyle diseases

2. Disease-Focused Innovation

Biotechnology interventions shall address priority public health challenges including:

- Cancer and chronic non-communicable diseases
- Cardiovascular and metabolic disorders
- Neurodegenerative and rare genetic diseases
- Emerging and re-emerging infectious diseases
- One Health challenges linking human, animal, and environmental health

The Policy shall encourage predictive, preventive, and precision healthcare models supported by biotechnology solutions.

3. Data, Surveillance and Advanced Infrastructure

The State shall strengthen healthcare biotechnology infrastructure through:

- Establishment of biobanks and rare disease registries
- Development of microbiome and population health datasets
- High-throughput surveillance platforms for outbreak monitoring
- GMP-compliant laboratories for diagnostics and biologics
- Shared core facilities and preclinical testing platforms
- State-managed secure digital repositories for biological data

Data governance shall ensure ethical use, privacy protection, and controlled data sharing aligned with national standards.

4. AI and Digital Biotechnology

The Policy shall promote integration of artificial intelligence and bioinformatics in healthcare through:

- AI-enabled bioinformatics and analytics platforms
- Knowledge and Analytics Centre for Biotechnology
- Startup acceleration programmes focused on AI-based healthcare solutions
- Secure digital health infrastructure and cybersecurity frameworks

5. Translational Research and Clinical Ecosystem

To accelerate innovation-to-impact pathways, the Policy shall:

- Support technology translation centres and clinical validation platforms
- Maintain a state-level database of clinical trial facilities and expertise
- Facilitate industry access to clinical research networks
- Explore establishment of a state-supported Clinical Research Organisation (CRO) model

6. Human Resource Development

The Policy shall strengthen workforce readiness through:

- Hands-on training programmes in genomics, diagnostics, and advanced biotechnology
- Industry-linked postgraduate and internship programmes
- Outcome-oriented postdoctoral research in health biotechnology
- Real-time industry and startup databases to support placements

7. Industry–Academia–Government Collaboration

Collaborative research shall be promoted through:

- Mission-mode healthcare biotechnology programmes
- Public–Private Partnerships in diagnostics, surveillance, and biomanufacturing
- Technology Transfer Offices and commercialization support systems
- Regional Biotechnology Research Clusters across the State

8. Equity, Ethics and Social Impact

Healthcare biotechnology initiatives shall ensure:

- Affordable diagnostics and technologies for rural and underserved populations
- Ethical governance of genomics and biological data
- Responsible use of AI and omics technologies
- Community engagement and public awareness

The Policy shall promote inclusive innovation ensuring biotechnology benefits reach all sections of society.

5.5 Ayurveda, Natural Products & Nutraceuticals

Kerala's rich heritage in Ayurveda, biodiversity resources, and traditional knowledge systems provides a unique opportunity to position the State as a global hub for scientifically validated natural products and nutraceutical innovation. The Policy shall promote convergence between traditional medicine and modern biotechnology through evidence-based research and responsible commercialization.

Strategic Objectives

- Promote biotechnology-enabled validation of Ayurveda and traditional formulations
- Support development of nutraceuticals, functional foods, and natural health products
- Encourage discovery of bioactive compounds from plant, microbial, and marine resources
- Strengthen quality assurance, standardization, and global regulatory compliance
- Enhance value addition to Kerala's biodiversity resources through sustainable utilization

Key Focus Areas

1. Research and Innovation

Support shall be provided for:

- Molecular characterization and validation of traditional formulations
- Omics-based studies for mechanism-of-action understanding

- Development of standardized extracts and phytopharmaceuticals
- Microbiome-based wellness and preventive health products
- Integrative medicine combining Ayurveda and modern biotechnology

2. Infrastructure Development

The State shall strengthen:

- Centres of Excellence in Nutraceuticals and natural product biotechnology
- Shared testing and validation laboratories
- GMP-compliant manufacturing and quality testing facilities
- Bio-resource databanks and genomic repositories

3. Industry and Entrepreneurship

The Policy shall encourage:

- Startups in nutraceuticals and Ayurveda-based biotechnology products
- Industry partnerships for scale-up and commercialization
- Market access support and global branding for Kerala-based products
- Integration with biotechnology parks and innovation clusters

4. Regulatory and Quality Framework

Efforts shall include:

- Scientific validation pathways aligned with national regulations
- Regulatory guidance for natural molecules and high-dose nutraceuticals
- Safety, efficacy, and quality standardization mechanisms
- Ethical use and protection of traditional knowledge resources

5. Sustainability and Bioeconomy Development

The Policy shall ensure:

- Sustainable sourcing of biological resources
- Biodiversity conservation and benefit-sharing mechanisms
- Promotion of green manufacturing and circular bioeconomy principles

6. ADVANCED TECHNOLOGIES

Advanced technologies are reshaping biotechnology by enabling data-driven innovation, precision interventions, and scalable bio-based solutions across healthcare, agriculture, industry, and environmental management. The Kerala Biotechnology Policy recognizes the strategic importance of integrating emerging technologies to strengthen research capabilities, accelerate innovation, and position the State within the evolving global bioeconomy.

The Policy shall promote adoption, development, and responsible deployment of advanced biotechnology platforms through coordinated investments in infrastructure, skilled human resources, collaborative research, and industry participation.

This section outlines cross-cutting advanced technologies that support innovation across all priority sectors identified in Section 5 of this Policy.

6.1 Artificial Intelligence and Machine Learning (AI/ML) in Biotechnology

The Policy shall promote the application of Artificial Intelligence (AI) and Machine Learning (ML) to enhance biotechnology research, diagnostics, and innovation outcomes.

Key initiatives include:

- Development of AI-driven platforms for biological data analysis and predictive modelling
- Integration of AI tools for disease surveillance, drug discovery, genomics, and precision agriculture
- Establishment of a Knowledge and Analytics Centre for Biotechnology to support evidence-based decision-making
- Support for startups developing AI-enabled biotechnology solutions
- Capacity-building programmes in computational biology and AI applications
- Promotion of ethical AI deployment aligned with data privacy and national governance frameworks

6.2 Genomics, NGS and Omics Technologies

The Policy shall strengthen genomics and multi-omics capabilities to support precision healthcare, crop improvement, biodiversity conservation, and bioresource utilization.

The State shall support:

- Expansion of Next Generation Sequencing (NGS) and omics platforms
- Development of genomic databases and population-scale biological datasets
- Integration of genomics into healthcare, agriculture, and animal biotechnology programmes
- Establishment and strengthening of biobanks and genomic repositories
- Promotion of microbiome and population genomics research relevant to Kerala
- Translation of genomics research into diagnostics, therapeutics, and agricultural innovations

All activities shall comply with national biosafety, ethical, and data governance regulations.

6.3 Synthetic Biology

The Policy recognizes synthetic biology as a transformative technology enabling sustainable manufacturing, biomolecule development, and next-generation biotechnology innovation.

The Policy shall:

- Promote research in synthetic biology for healthcare, agriculture, and industrial biotechnology applications
- Support establishment of synthetic biology research and training centres
- Encourage development of skilled manpower through specialized academic programmes
- Facilitate biofoundries and automated biological design platforms
- Strengthen industry–academia collaboration for commercialization of synthetic biology innovations

Implementation shall adhere to biosafety, biosecurity, and ethical oversight frameworks.

6.4 Bioinformatics and Data Science

Bioinformatics and data science shall serve as foundational pillars supporting modern biotechnology research and innovation.

The Policy shall promote:

- State-level bioinformatics platforms for genomics and multi-omics data analysis
- Integrated biological data repositories with secure storage and standardized data formats
- AI- and analytics-driven research for healthcare, agriculture, and environmental applications
- Establishment of a Knowledge and Analytics Centre for Biotechnology
- Training programmes in computational biology, biostatistics, and data science
- Support for startups developing bioinformatics tools and digital biotechnology platforms
- Strong data governance ensuring privacy, cybersecurity, and ethical data use

Responsible data sharing shall be encouraged while safeguarding confidentiality and public interest.

Kerala Genome Data Centre (KGDC)

The Kerala Genome Data Centre (KGDC) shall function as the State's flagship genomics facility supporting bioresource sequencing, genomic data generation, and translational biotechnology research.

The State shall strengthen KGDC to:

- Undertake sequencing of medicinal plants and other biologically important bioresources of Kerala
- Develop and maintain state-level genomic databases and data repositories
- Enable regulated access to genomic data for academia, research institutions, and industry
- Promote responsible data sharing and open-data practices wherever feasible
- Support innovation in healthcare, agriculture, biodiversity conservation, and natural product development

The Kerala Biotechnology Commission (KBC) shall coordinate development of data access guidelines and utilization frameworks to ensure ethical use, scientific advancement, and bioeconomy growth.

7. BIOTECHNOLOGY INFRASTRUCTURE FRAMEWORK

A robust and accessible infrastructure ecosystem is essential for advancing biotechnology research, innovation, and industrial growth. The Kerala Biotechnology Policy shall strengthen biotechnology infrastructure through integrated development of research facilities, innovation clusters, shared platforms, and biomanufacturing capabilities.

The framework shall reduce infrastructure gaps, promote collaborative research, enable startup growth, and accelerate translation of scientific discoveries into products and services. Infrastructure development shall prioritize accessibility for academic institutions, startups, MSMEs, and industry partners while ensuring alignment with national and global standards.

7.1 Biotech Parks and Innovation Clusters

The Policy shall promote the development of biotechnology parks and regional innovation clusters to create collaborative ecosystems connecting academia, industry, startups, and government institutions.

Key initiatives include:

- Development and expansion of biotechnology parks across the State
- Establishment of regional biotechnology innovation clusters in major knowledge hubs
- Promotion of plug-and-play infrastructure for startups and MSMEs
- Strengthening industry–academia collaboration through co-located research facilities
- Development of thematic clusters focusing on healthcare, agriculture, marine biotechnology, and bioindustrial applications

Biotech parks shall function as integrated ecosystems supporting incubation, research, pilot-scale validation, and commercialization.

7.2 Bio360 Life Science Park, Thonnakkal

Bio360 Life Science Park, Thonnakkal, shall serve as the State's flagship biotechnology and biomanufacturing hub.

The Policy shall support its development and operationalization through collaboration between the Kerala Biotechnology Commission (KBC) and Kerala Life Sciences Industries Park Pvt. Ltd. under KSIDC.

Key focus areas include:

- Establishment of advanced research and innovation facilities
- Promotion of biomanufacturing and translational biotechnology activities
- Development of incubation and startup support infrastructure
- Facilitation of public–private partnerships in biotechnology research and production
- Creation of integrated ecosystems supporting healthcare biotechnology, vaccines, biologics, and emerging technologies

Bio360 shall evolve as a national-level biotechnology innovation and manufacturing destination.

7.3 Shared Core Facilities

The Policy shall promote shared access to advanced scientific equipment and specialized facilities to optimize resource utilization and reduce entry barriers for researchers and startups.

Key provisions include:

- Establishment of shared core laboratories equipped with high-end instrumentation
- Centralized facilities for genomics, proteomics, imaging, and analytical testing
- Access mechanisms for academic institutions, startups, and MSMEs
- Reliable maintenance, servicing, and technical support systems
- Digital booking and facility management platforms

Shared facilities shall enable collaborative research and cost-effective innovation.

7.4 BSL Laboratories and Preclinical Platforms

To strengthen research preparedness and biosecurity, the Policy shall support development and operationalization of biosafety and preclinical infrastructure.

The State shall promote:

- Operationalization of BSL-3 and advanced containment laboratories at strategic locations including the Institute of Advanced Virology and Bio360 Life Science Park
- Establishment of accredited animal facilities and preclinical testing platforms
- Public–Private Partnership (PPP) models for high-containment laboratory infrastructure
- Strengthening biosafety compliance and operational standards

7.5 Bioprocessing and Manufacturing Units

The Policy shall strengthen bioprocessing and pilot-scale manufacturing capabilities to bridge the gap between laboratory research and industrial production.

Key initiatives include:

- Establishment of pilot-scale bioprocessing facilities accessible to startups and MSMEs
- Development of GMP-compliant manufacturing infrastructure for biologics, diagnostics, and bio-based products
- Promotion of scale-up facilities within biotechnology parks
- Support for contract manufacturing and technology validation platforms
- Encouragement of industry participation in biomanufacturing ecosystems

7.6 Biobanks and Data Repositories

The Policy shall establish integrated biological resource and data infrastructure to support research, precision medicine, and biotechnology innovation.

Key provisions include:

- Development of state-level biobanks and rare disease registries

- Strengthening genomic and biological data repositories, including the Kerala Genome Data Centre (KGDC)
- Standardized protocols for biological sample collection, storage, and sharing
- Secure digital infrastructure ensuring data protection and ethical compliance
- Controlled access frameworks for academia, research institutions, and industry
- Establishment of a Microbial Resource Bank under the Centre of Excellence in Microbiome for systematic collection, preservation, characterization, and regulated utilization of microbial resources to support research and innovation

Focus Area: Biofoundries

Biofoundries are advanced automated platforms integrating synthetic biology, robotics, artificial intelligence, and high-throughput experimentation to accelerate biological design and product development. The Policy shall promote shared-access biofoundry capabilities utilizing existing biotechnology infrastructure to support startups, research institutions, and industry through rapid design–build–test–learn workflows and pilot-scale validation, enabling faster translation of research into scalable bio-based solutions.

From discovery to scalable bioinnovation.

8. HUMAN RESOURCE DEVELOPMENT FRAMEWORK

The Kerala Biotechnology Policy recognizes human resource development (HRD) as a foundational pillar for building a sustainable and innovation-driven biotechnology ecosystem. The Policy aims to create a future-ready biotechnology workforce by aligning education, research training, industry requirements, and entrepreneurship pathways with emerging global and national biotechnology trends.

The HRD framework shall focus on bridging the gap between academic training and industry needs, strengthening practical skills, promoting interdisciplinary learning, and enabling continuous professional development across all levels of the biotechnology workforce.

Implementation shall be coordinated by the Kerala Biotechnology Commission (KBC) in collaboration with universities, research institutions, industry partners, skill development agencies, and innovation ecosystems.

8.1 Skill Development Strategy

The Policy shall promote structured skill development programmes to create industry-ready biotechnology professionals.

Key initiatives include:

- Development of modular, hands-on training programmes across diploma, undergraduate, postgraduate, and doctoral levels
- Integration of emerging domains such as genomics, bioinformatics, AI/ML in biotechnology, regulatory science, and synthetic biology into training curricula
- Industry-aligned certification programmes developed jointly with academia and industry partners
- Promotion of laboratory immersion, instrument familiarization, and applied research training
- Flexible learning pathways including hybrid, online, and weekend certification programmes

- Alignment of skill programmes with national initiatives including BioE3 and workforce needs of the bioeconomy

8.2 Finishing Schools & Training Centres

The State shall establish specialized biotechnology finishing schools and training centres to enhance employability and translational skills.

Key provisions include:

- Establishment of Biotech Finishing Schools / Industry–Academia Skill Centres offering 6–12-month advanced training programmes
- Creation of a Kerala Biotech Skill & Training Hub (KBSTH) supported by shared infrastructure
- Regional Biotechnology Instrumentation Centres providing access to advanced equipment on a shared-user basis
- Training in areas such as:
    - genome editing and molecular diagnostics
    - vaccine and biomanufacturing technologies
    - quality control and regulatory compliance
    - computational biology and data science
- Mobile biotechnology training units to extend training access to rural institutions and students

8.3 Faculty Development & Mentorship

The Policy shall strengthen academic capacity through continuous faculty development and expert mentorship mechanisms.

Key initiatives:

- Faculty Development Programmes (FDPs) in emerging biotechnology domains
- Faculty–industry sabbaticals and exposure programmes
- Training-of-trainers programmes for educators and technical staff
- Engagement of industry experts and startup professionals as:

    - Adjunct Faculty
    - Visiting Innovation Faculty
    - Mentors-in-Residence
- Establishment of regional training centres for faculty upskilling and curriculum modernization

8.4 Industry Internship Framework

To bridge academia–industry gaps, the Policy shall institutionalize structured internship and apprenticeship pathways.

Key measures include:

- Creation of a Kerala Biotech Talent Consortium (KBTC) involving government, academia, and industry
- Mandatory industry exposure modules within biotechnology degree programmes
- Six-month industry-oriented training pathways for doctoral scholars
- Co-supervised research projects between academia and industry
- Centralized internship and placement portal managed by KBC
- Startup-led capstone projects and innovation challenges

8.5 State Fellowships

The Policy shall introduce targeted fellowship programmes to attract and retain talent within Kerala's biotechnology ecosystem.

Key provisions:

- Kerala Biotechnology Research Fellowships for UG, PG, PhD, and postdoctoral researchers
- Competitive fellowships aligned with national standards
- Re-entry fellowships for scientists and postdoctoral researchers of Kerala origin working abroad
- Travel grants for international collaboration and conference participation
- Innovation scholarships and student research grants aligned with state priority sectors

8.6 KBTC / BIACC Cells

Institutional mechanisms shall be created to sustain industry–academia engagement.
These include:

- **Kerala Biotech Talent Consortium (KBTC)** to identify workforce needs and guide curriculum development
- Establishment of **Biotech Industry–Academia Collaboration Cells (BIACC)** in institutions to:
    - coordinate industry engagement
    - maintain expert databases
    - facilitate mentorship and internships
    - support joint research and innovation programmes
- Digital mentorship platforms connecting industry experts with students and startups

8.7 HRD Monitoring Mechanism

A dedicated HRD Monitoring Cell shall be established under KBC to track outcomes and ensure effective implementation.
Monitoring indicators shall include:

- Graduate employability and placement outcomes
- Industry internship participation
- Research outputs and intellectual property generation
- Startup creation and innovation outcomes
- Gender equity and regional inclusion
- Skill alignment with industry demand

Annual HRD implementation plans with measurable targets shall be prepared and reviewed periodically.

8.8 Institutional Consortium for Human Resource Development

The Policy shall promote the formation of a Biotechnology Institutional Consortium involving universities, R&D institutions, and industry partners to enable coordinated training, research mentoring, and collaborative programmes, as recommended by the Expert Committee.

The consortium shall:

- Enable shared training infrastructure and faculty exchange.
- Support interdisciplinary research training.
- Reduce administrative barriers to collaboration.
- Align human resource development with state biotechnology priorities.
- Specific guidelines shall be developed by the Kerala Biotechnology Commission (KBC) to define governance structure, operational modalities, resource sharing mechanisms, and collaborative programme implementation under the consortium framework.

9. INDUSTRY PROMOTION & STARTUP ECOSYSTEM

The Policy shall promote a vibrant biotechnology industry ecosystem by enabling innovation, entrepreneurship, investment, and industry–academia collaboration. Special emphasis shall be placed on supporting startups, MSMEs, translational research, and commercialization pathways through coordinated institutional mechanisms involving the Kerala Biotechnology Commission (KBC), Kerala Startup Mission (KSUM), Kerala State Industrial Development Corporation (KSIDC), and allied agencies.

The framework shall facilitate ease of doing business, regulatory clarity, and access to infrastructure, funding, and market opportunities for biotechnology enterprises.

9.1 Single Window Facilitation Mechanism

The Policy shall leverage and strengthen the State's existing **Kerala Single Window Interface for Fast and Transparent Clearance (KSWIFT)** platform as the primary facilitation mechanism for biotechnology industries and startups.

Key provisions include:

- Integration of biotechnology-specific approvals and services within the KSWIFT system
- Time-bound processing of approvals, registrations, and clearances
- Coordinated inter-departmental facilitation for land allotment, utilities, and statutory compliance
- Dedicated support interface for biotechnology enterprises through KBC in coordination with KSIDC
- Digital tracking and grievance redressal mechanisms to ensure transparency and efficiency

The system shall function as a unified access point for investors, startups, and industries establishing biotechnology operations in Kerala.

9.2 Startup Incentives & Incubation Support

The Policy shall promote biotechnology entrepreneurship through targeted incentives and incubation support.

Key measures include:

- Establishment and strengthening of biotechnology incubators and wet-lab facilities
- Plug-and-play laboratory infrastructure within biotechnology parks and innovation clusters
- Seed funding, innovation grants, and early-stage support mechanisms
- Incentives linked to product development milestones, intellectual property generation, and employment creation
- Mentorship, business acceleration, and market access support in collaboration with KSUM and industry partners
- Promotion of "Buy Local Biotech" initiatives to support Kerala-based innovations

9.3 Public–Private Partnership (PPP) Framework

The Policy shall encourage Public–Private Partnerships to accelerate biotechnology infrastructure development, research translation, and commercialization.

The PPP framework shall support:

- Establishment and operation of advanced research facilities and biomanufacturing units
- Development of shared infrastructure including high-containment laboratories and testing facilities
- Collaborative R&D programmes involving academia, industry, and government institutions
- Joint funding models for translational research and technology deployment

Transparent governance and risk-sharing mechanisms shall be adopted to ensure sustainability and accountability.

9.4 Technology Transfer Offices

The Policy shall promote the establishment of Technology Transfer Offices (TTOs) across major research institutions and biotechnology clusters.

TTOs shall:

- Facilitate commercialization of research outcomes
- Support intellectual property management and licensing
- Assist startups and industries in technology acquisition and scaling
- Enable industry–academia collaboration and contract research partnerships
- Provide advisory services on regulatory pathways and market readiness

KBC shall coordinate a state-level network of TTOs to strengthen innovation translation.

9.5 Clinical Trial Facilitation

The Policy shall support the development of Kerala as a preferred destination for ethical and high-quality clinical research.

Key initiatives include:

- Creation of a State-level database of clinical trial facilities, expertise, and institutional capabilities
- Facilitation of linkages between startups, industry, and accredited clinical trial centres
- Coordination support through KBC while regulatory oversight remains with the Health Department and national authorities
- Promotion of Good Clinical Practice (GCP) standards and ethical compliance

This framework shall enhance translational healthcare innovation and biomedical product development.

9.6 CRO Support & Regulatory Guidance

The Policy shall promote the growth of Contract Research Organizations (CROs) and regulatory support services within the State.

Key provisions include:

- Facilitation of CRO establishment within biotechnology parks and innovation clusters
- Regulatory guidance support for diagnostics, biologics, nutraceuticals, and advanced therapies
- Advisory mechanisms to assist startups in navigating national regulatory pathways
- Capacity building programmes on quality standards, certification, and compliance requirements
- Exploration of a state-supported CRO model to assist early-stage biotechnology enterprises

10. FUNDING ARCHITECTURE

The Kerala Biotechnology Policy shall establish an integrated and mission-oriented funding framework to support research, innovation, entrepreneurship, human resource development, and global collaboration across the biotechnology ecosystem.

To ensure coordinated implementation and efficient financial management, a **Kerala Biotechnology Mission Fund** shall be created as the principal funding mechanism for all biotechnology programmes under this Policy.

The Mission Fund shall function under the **strategic guidance of the Kerala Biotechnology Commission (KBC)** and shall be operationalized through a **Section 8 Company established for biotechnology programme implementation, resource mobilization, and fund management**.

The funding architecture shall support the entire innovation lifecycle — from research and skill development to commercialization and global partnerships.

10.1 Kerala Biotechnology Mission Fund

The Kerala Biotechnology Mission Fund shall serve as the umbrella financial framework for implementing biotechnology initiatives in the State.

The Fund shall:

- Support mission-mode biotechnology programmes aligned with State priorities
- Enable translational research and product development
- Promote startup creation and industrial innovation
- Strengthen human resource development and skill ecosystems
- Facilitate infrastructure development and shared facilities
- Mobilize resources through Government allocations, PPP models, CSR contributions, national programmes, and international funding agencies

The Section 8 Company shall administer the Fund with transparent financial governance, outcome-based funding mechanisms, and periodic monitoring under KBC oversight.

10.2 Translational Research Grants

The Mission Fund shall provide **Translational Research Grants** to bridge the gap between laboratory research and market-ready technologies.

Support shall include:

- Proof-of-concept validation and prototype development
- Pilot-scale testing and technology demonstration
- Industry-linked collaborative research projects
- Commercialization readiness and technology transfer support

Funding shall be milestone-based and linked to measurable outcomes.

10.3 Startup Seed Fund

A dedicated **Startup Seed Fund** shall operate under the Mission Fund to promote biotechnology entrepreneurship.

The Seed Fund shall:

- Provide pre-seed and seed-stage funding support
- Assist startups in prototype development and regulatory preparedness
- Support incubation, mentoring, and market access initiatives
- Encourage deep-technology and research-intensive startups
- Enable co-investment with private investors and venture capital partners

Priority shall be given to startups emerging from academic and research institutions within Kerala.

10.4 Fellowship Schemes and Skilling Support

The Mission Fund shall support comprehensive human resource development through fellowship and skilling programmes.

These shall include:

- Doctoral and postdoctoral fellowships in priority biotechnology domains
- Re-entry fellowships for researchers of Kerala origin working abroad
- Industry-linked research fellowships and innovation fellowships

- Student internships and apprenticeship programmes across institutions and industries
- Skill development and advanced technology training programmes aligned with industry needs

Fellowship support shall aim to attract, nurture, and retain high-quality biotechnology talent within the State.

10.5 National and International Collaboration Fund

A dedicated National and International Collaboration Fund shall be established under the Kerala Biotechnology Mission Fund to strengthen partnerships, knowledge exchange, and collaborative research across institutions, industries, and global biotechnology networks.

The Fund shall support:

- Collaborative research programmes with national research institutions, universities, and industry partners
- Joint initiatives aligned with national missions and programmes of the Government of India, including DBT and BioE3 initiatives
- International research collaborations, technology partnerships, and innovation networks
- Researcher exchange programmes, visiting scientist schemes, and joint training initiatives
- Participation in global biotechnology consortia, conferences, and innovation platforms
- Access to international funding opportunities and multilateral research programmes

The Fund shall facilitate technology transfer, capacity building, and global market linkages while positioning Kerala as an active participant in the national and global bioeconomy ecosystem.

11. REGULATORY & BIOSAFETY FRAMEWORK

A transparent, efficient, and science-based regulatory ecosystem is essential to enable biotechnology innovation while ensuring protection of human health, environmental sustainability, and ethical governance. As biotechnology advances into areas such as genomics, synthetic biology, advanced therapeutics, and data-driven life sciences, regulatory systems must evolve to support innovation without compromising biosafety and public trust. The Kerala Biotechnology Policy shall establish a coordinated Regulatory and Biosafety Framework that facilitates responsible research, accelerates industrial development, and ensures compliance with national and international standards. The framework shall align with Government of India regulations and applicable biosafety guidelines while introducing State-level facilitation mechanisms to reduce procedural complexity.

The Kerala Biotechnology Commission (KBC) shall function as the nodal coordination agency for regulatory facilitation, stakeholder guidance, and interdepartmental convergence related to biotechnology activities within the State.

The framework shall emphasize:

- Ease of doing research and business in biotechnology
- Responsible innovation and ethical oversight
- Biosafety and biosecurity compliance
- Secure and accountable data governance
- Integrated health surveillance under a One Health approach

11.1 Single Window Clearance (K-SWIFT Integration)

To improve ease of doing business and research, the Policy shall leverage the Kerala Single Window Interface for Fast and Transparent Clearance (K-SWIFT) as the primary platform for biotechnology-related approvals.

K-SWIFT shall serve as the unified digital interface for coordinated processing of permissions required for research facilities, startups, manufacturing units, laboratories, and innovation infrastructure.

Key provisions include:

- Integration of biotechnology approvals within the K-SWIFT platform.
- Single online application system covering multiple departmental clearances.
- Coordination among departments including Industries, Health, Environment, Agriculture, Animal Husbandry, Fisheries, Local Self-Government Institutions, and Pollution Control authorities.
- Regulatory guidance support through KBC for researchers, startups, and investors.
- Digital tracking, real-time status updates, and automated communication.
- Transparent grievance redressal mechanisms and compliance guidance.

11.2 Time-Bound Approvals

To promote innovation and investment confidence, the Policy shall introduce structured time-bound approval systems for biotechnology-related activities within the State's administrative jurisdiction.

All concerned departments shall adopt defined service timelines supported by digital workflow systems and performance monitoring mechanisms.

Key measures include:

- Establishment of standard processing timelines for clearances and certifications.
- Parallel processing of multi-department approvals wherever feasible.
- Risk-based categorization of biotechnology activities to enable faster approval for low-risk research and innovation.
- Automated status updates through digital platforms.
- Periodic review of approval efficiency under KBC oversight.

11.3 Data Governance

Biological and health data are recognized as strategic resources requiring secure and ethical governance. The Policy shall establish a comprehensive Data Governance Framework to ensure secure, ethical, and responsible management of biotechnology data.

The framework shall support innovation while safeguarding privacy, confidentiality, and public interest.

Key provisions include:

- Development of standardized protocols for collection, storage, and sharing of biological and research data.
- Secure digital repositories aligned with national data protection regulations.
- Controlled access mechanisms for genomic, clinical, agricultural, and environmental datasets.
- Interoperability standards enabling collaboration among institutions.
- Cybersecurity safeguards for biotechnology databases and digital platforms.
- Ethical oversight mechanisms governing data usage and sharing.

11.4 Biobank & Rare Disease Registry

The Policy shall strengthen biological resource management and precision health research through establishment of integrated Biobank and Rare Disease Registry systems across the State.

These platforms shall support clinical research, genomics, diagnostics development, and evidence-based healthcare planning.

Key initiatives include:

- Establishment of state-level biobanks with standardized biospecimen collection and storage protocols.
- Development of a Rare Disease Registry to support early diagnosis, epidemiological analysis, and research prioritization.
- Integration of clinical, genomic, and population health datasets under secure governance frameworks.
- Ethical consent procedures and patient data protection mechanisms.
- Networking of institutional biobanks across medical colleges, research centres, and biotechnology institutions.
- Promotion of translational research using curated biological samples.

All activities shall comply with national ethical guidelines and biosafety standards.

11.5 One Health Surveillance

The Policy adopts a One Health approach recognizing the interconnected nature of human, animal, and environmental health systems. Strengthening integrated surveillance mechanisms shall enhance preparedness against emerging diseases, zoonotic infections, and antimicrobial resistance.

The State shall establish coordinated One Health surveillance systems through collaboration among health, veterinary, agriculture, fisheries, and environmental departments.

Key measures include:

- Integration of human and animal disease surveillance networks.
- Genomic surveillance for early detection of emerging pathogens.
- Strengthening zoonotic disease monitoring and antimicrobial resistance surveillance programmes.
- Data-sharing platforms linking healthcare institutions, veterinary laboratories, and environmental monitoring systems.
- Development of interdisciplinary One Health research and response teams.
- Capacity-building programmes for surveillance professionals and researchers.

One Health Priority: Antimicrobial Resistance (AMR)

Antimicrobial Resistance (AMR) poses a growing risk to human health, animal health, food safety, and environmental sustainability. The Policy adopts a One Health approach to strengthen integrated surveillance, promote responsible antimicrobial use, and support evidence-based treatment practices across healthcare and veterinary systems. Biotechnology-enabled tools such as rapid diagnostics, genomic surveillance, and microbiome research shall be encouraged to enable early detection and informed response to resistant pathogens.

Healthy People • Healthy Animals • Healthy Environment

Implementation and Oversight

Implementation of the Regulatory & Biosafety Framework shall be coordinated by the Kerala Biotechnology Commission in collaboration with relevant State departments and national regulatory authorities.

Periodic review mechanisms shall be instituted to:

- Evaluate regulatory efficiency,
- Update biosafety practices,
- Address emerging technological risks,
- Strengthen stakeholder engagement and public awareness.

Through this framework, Kerala shall establish a biotechnology ecosystem characterized by innovation-friendly governance, strong biosafety assurance, ethical responsibility, and global regulatory alignment.

12. BIOTECHNOLOGY FOR RURAL DEVELOPMENT

Biotechnology presents a strategic opportunity to drive inclusive economic growth, strengthen livelihoods, and enable sustainable utilization of biological resources. Kerala's diverse agro-climatic conditions, coastal ecosystems, traditional knowledge, and community-based development models provide a solid foundation for applying biotechnology solutions at the grassroots level.

The Kerala Biotechnology Policy shall promote decentralized interventions that enhance agricultural productivity, support rural enterprises, improve environmental sustainability, and create skilled employment in rural and coastal regions. The priority shall be given to translating scientific innovations into practical field-level applications through community participation, institutional partnerships, and technology outreach, with emphasis on farmer-centric innovation and bioresource value addition.

Implementation shall be coordinated by the Kerala Biotechnology Commission (KBC) in collaboration with local self-government institutions, academic and research organizations, cooperatives, and rural development agencies.

12.1 Rural Biotechnology Mission

A **Rural Biotechnology Mission** shall be launched to promote biotechnology-based solutions addressing key rural development challenges. The Mission shall support the adoption of technologies that improve agriculture, environmental management, and rural bio-based enterprises.

The Mission shall focus on:

- Promoting climate-resilient and sustainable farming practices.
- Encouraging production and use of biofertilizers, biopesticides, and other eco-friendly bio-inputs.
- Supporting rural entrepreneurship based on biological resources and value-added products.

- Improving soil health, water quality, and waste management using biotechnology solutions.
- Encouraging participation of women and youth in bio-based livelihood activities.

Implementation shall follow a cluster-based approach, identifying region-specific opportunities based on local resources and community needs.

12.2 Farmer Field Schools

Biotechnology-enabled **Farmer Field Schools** shall be established to help farmers understand and adopt modern scientific practices through hands-on learning.

These schools shall serve as demonstration and training platforms connecting scientists with farming communities.

Key activities include:

- Demonstration of biofertilizers and biopesticides for sustainable agriculture.
- Training on early detection and management of crop pests and diseases.
- Awareness programmes on climate-resilient crop varieties and improved cultivation practices.
- Soil health management and nutrient optimization techniques.
- Post-harvest handling and value addition methods.

The programme shall encourage participation of small and marginal farmers, farmer producer organizations, and youth interested in agri-based entrepreneurship.

12.3 Coastal Bioeconomy Programmes

The Policy shall introduce **Coastal Bioeconomy Programmes** to improve livelihoods in coastal regions through sustainable use of marine biological resources.

These programmes shall combine biotechnology innovation with environmental conservation and community participation.

Key focus areas include:

- Promotion of sustainable aquaculture and mariculture practices.

- Development of value-added products from marine resources such as nutraceuticals and functional foods.
- Use of marine biotechnology for pollution control and coastal ecosystem restoration.
- Skill development programmes for fisherfolk and coastal youth.

These initiatives shall support income diversification while ensuring conservation of marine biodiversity.

12.4 Mobile Biotechnology Units

To ensure access to biotechnology knowledge in remote and rural areas, **Mobile Biotechnology Units** shall be deployed across the State.

These units shall function as travelling training and demonstration laboratories bringing science directly to communities.

Major activities include:

- Conducting awareness and training programmes for farmers, students, and rural entrepreneurs.
- Demonstrating practical biotechnology applications in agriculture and environmental monitoring.
- Providing field-level support for plant and animal disease identification.
- Promoting biotechnology education in schools and rural institutions.
- Identifying grassroots innovations and supporting local entrepreneurs.

13. IMPLEMENTATION ROADMAP (2026–2030)

The implementation of the Kerala Biotechnology Policy shall follow a phased and time-bound roadmap to ensure systematic development of governance systems, infrastructure, innovation ecosystems, and global partnerships. The **Implementation Roadmap (2026–2030)** provides a structured pathway for translating policy goals into measurable outcomes through coordinated institutional action.

The roadmap adopts a three-phase strategy progressing from ecosystem strengthening to expansion and finally global positioning of Kerala's biotechnology sector.

Implementation shall be coordinated by the Kerala Biotechnology Commission (KBC) under the strategic guidance of the Kerala Biotechnology Board, in collaboration with State departments, research institutions, industry partners, and innovation agencies.

13.1 Phase I – Foundation (2026–2027)

The Foundation Phase shall focus on establishing governance mechanisms, regulatory facilitation systems, and core institutional capacities required for effective policy implementation.

Governance and Institutional Strengthening

- Operationalization of implementation mechanisms under KBC.
- Establishment of the proposed Section 8 Company for programme execution and fund management.
- Constitution of Sectoral Councils and expert advisory groups.
- Preparation of operational guidelines and programme frameworks.

Regulatory Enablement

- Integration of biotechnology services within the K-SWIFT single window clearance system.
- Introduction of time-bound approval mechanisms.
- Development of biosafety, biosecurity, and data governance guidelines.

- Establishment of regulatory facilitation support for startups and research institutions.

Infrastructure Planning

- Detailed planning for biotechnology parks, shared core facilities, and biomanufacturing infrastructure.
- Strengthening Bio360 Life Science Park as the State's flagship biotechnology hub.
- Planning for biobanks, genomic repositories, and digital data infrastructure.

Human Resource Initiatives

- Launch of biotechnology skill development programmes and finishing schools.
- Initiation of fellowship, internship, and industry-linked training schemes.
- Establishment of industry–academia collaboration platforms.

This phase shall create the institutional and regulatory foundation for accelerated biotechnology growth.

13.2 Phase II – Expansion (2027–2029)

The Expansion Phase shall focus on scaling infrastructure, research translation, startup growth, and statewide programme implementation.

Infrastructure Development

- Operationalization of shared core laboratories and pilot-scale facilities.
- Expansion of incubation centres and wet-lab infrastructure.
- Operationalization of BSL laboratories and preclinical research platforms.

Industry and Startup Ecosystem

- Implementation of startup seed funding and innovation support schemes.
- Strengthening Technology Transfer Offices across institutions.
- Promotion of Contract Research Organizations (CROs).
- Attraction of private investment and industry partnerships.

Sectoral Programme Deployment

- Implementation of Rural Biotechnology Mission and Farmer Field Schools.
- Launch of Coastal Bioeconomy programmes.
- Expansion of healthcare biotechnology and genomics initiatives.
- Deployment of Mobile Biotechnology Units across districts.

Data and Digital Systems

- Strengthening operations of the Kerala Genome Data Centre.
- Development of integrated biological data platforms.
- Establishment of secure data-sharing and governance frameworks.

This phase shall significantly expand biotechnology activities across the State ecosystem.

13.3 Phase III – Scale & Global Positioning (2029–2030)

The final phase shall focus on achieving global competitiveness and positioning Kerala as a leading bioeconomy destination.

Biomanufacturing and Commercialization

- Establishment of advanced biomanufacturing and scale-up facilities.
- Support for commercialization of research outcomes and technology deployment.
- Promotion of export-oriented biotechnology products and services.

Global Engagement

- Expansion of international research collaborations and partnerships.
- Participation in global biotechnology innovation networks.
- Promotion of Kerala as a destination for biotechnology investment and clinical research.

Innovation Leadership

- Development of biofoundries and advanced technology platforms.
- Expansion of AI-enabled biotechnology and digital bioeconomy initiatives.
- Promotion of synthetic biology and precision health innovation.

Sustainable Bioeconomy Growth

- Scaling rural and coastal bioeconomy enterprises.
- Integration of circular bioeconomy principles.
- Monitoring environmental sustainability and societal impact.

By the end of Phase III, Kerala shall emerge as a nationally leading and globally connected biotechnology ecosystem contributing significantly to innovation-led economic growth and sustainable development.

Expected Outcomes (2026–2030)

Implementation of the roadmap is expected to achieve:

- Growth of biotechnology startups and industries
- Increased research commercialization and innovation outputs
- Strengthened biotechnology infrastructure across the State
- Creation of a skilled biotechnology workforce
- Expansion of bioeconomy contribution to the State economy
- Enhanced national and global visibility of Kerala's biotechnology ecosystem

14. MONITORING & EVALUATION FRAMEWORK

Effective monitoring and evaluation are essential to ensure that the Kerala Biotechnology Policy delivers measurable outcomes and real societal benefits. The Monitoring & Evaluation (M&E) Framework shall provide a structured system to track progress, assess impact, and support timely decision-making throughout the implementation period.

The framework shall focus on transparency, accountability, and continuous improvement, ensuring that policy initiatives remain aligned with evolving scientific, economic, and societal needs.

14.1 Monitoring Approach

The Kerala Biotechnology Commission (KBC) shall serve as the nodal agency responsible for monitoring implementation of programmes under this Policy. Monitoring shall be carried out through periodic data collection, programme reviews, and stakeholder consultations.

Key principles guiding monitoring include:

- Outcome-oriented implementation rather than activity-based reporting
- Evidence-based decision-making
- Transparency in programme performance
- Flexibility to adapt to emerging priorities

Digital monitoring systems shall be developed to track progress across departments, institutions, and programmes.

14.2 Key Performance Indicators

Progress under the Policy shall be assessed using measurable indicators across major focus areas, including:

- Growth of biotechnology startups and industries
- Research outputs, patents, and commercialization outcomes
- Infrastructure utilization and investment mobilization
- Employment generation and skill development achievements

- Adoption of biotechnology solutions in agriculture, healthcare, and environmental sectors
- Expansion of rural and coastal bioeconomy initiatives

These indicators shall help evaluate both economic impact and societal benefits.

14.3 Review Mechanisms

Regular review mechanisms shall ensure timely course correction and effective implementation.

- **Annual Reviews:** Assessment of programme progress and achievement of targets.
- **Mid-term Review:** Comprehensive evaluation of policy performance and implementation challenges.
- **Expert Consultations:** Periodic engagement with academia, industry, and domain experts to refine strategies.

Findings from reviews shall guide programme improvements and future policy decisions.

14.4 Impact Assessment

Independent impact assessments may be conducted for major initiatives to evaluate long-term outcomes such as innovation growth, employment generation, sustainability impact, and contribution to the State's bioeconomy.

The assessments shall focus on:

- Translation of research into practical applications
- Industry and startup growth
- Benefits to rural and community stakeholders
- Environmental and public health outcomes

14.5 Transparency and Stakeholder Participation

The Policy shall promote open communication and stakeholder participation in monitoring processes through:

- Periodic progress reports and public dissemination of key outcomes

- Stakeholder consultations and feedback mechanisms
- Engagement with industry, academia, startups, and community organizations

This participatory approach shall strengthen public trust and encourage collaborative implementation.

KERALA STATE COUNCIL
FOR SCIENCE TECHNOLOGY AND ENVIORNMENT
Sasthra Bhavan,Pattom, Thiruvananthapuram