

National Biotechnology Policy

**Ministry of Science and
Information & Communication Technology**

Government of the People's Republic of Bangladesh

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Abbreviations:

BT:	Biotechnology.
DNA:	Deoxyribonucleic Acid.
GMO:	Genetically Modified Organism
ICT:	Information & Communication Technology.
IPR:	Intellectual Property Right.
LMO:	Living Modified Organism.
MDG:	Millennium Development Goal.
MOSICT:	Ministry of Science and Information & Communication Technology.
NGO:	Non-Government Organisation.
R&D:	Research and Development.
RAPD:	Random Amplification of Polymorphic DNA.
RFLP:	Restriction Fragment Length Polymorphism
SNP:	Single Nucleotide Polymorphism.
UN:	United Nations.
UNCED:	United Nations Conference on Environment and Development.
WEHAB:	Water, Energy, Health, Agriculture and Biotechnology.
WSSD:	World Summit on Sustainable Development.

NATIONAL BIOTECHNOLOGY POLICY

1. PREAMBLE

Biotechnology involves application of tools and techniques using biological systems, living organisms, or derivatives there of, to make or modify products or processes for desired use. The technology based on biological systems- plants, animals and microbes has, of course, been practiced for thousands of years through conventional methods and it still plays a dominant role in providing goods and services. Genetic engineering is the pivot of modern biotechnology which has opened up wide opportunities in the development of new and novel types of crops, improvements in farming system by reducing costs of fertilizers and pesticides. Significant improvements have been achieved in livestock production, forestry, fisheries, health and nutrition and environment management areas by using modern biotechnological tools and techniques.

1.1. Biotechnology - World Scenario

The last 25-30 years have been the golden age for biotechnology. Within this short span of time recombinant DNA technology, which was hitherto considered primarily a fundamental subject has proved beyond doubt its applicability in many areas of human welfare. In the area of public health modern biotechnology has provided healthful products like fruits and vegetables with higher level of vitamins C, E and beta carotene; **Golden rice** with precursor of vitamin A promises to help prevent night blindness and related diseases. Genetically modified banana containing vaccine against diarrhoea has been produced. Modern medicinal products in commercial use developed by modern biotechnology include insulin, hepatitis B vaccine etc. By now many genetically engineered human pharmaceuticals have been approved for testing. Similarly many transgenic crops including soybean, cotton, sugar beet, rice and wheat have already been released for cultivation in some developed and developing countries.

In agriculture, biotechnology has helped increase in productivity in crops, livestock, fishery and forestry sectors. This technology has helped in controlling pests and diseases through enhanced genetic resistance, improved diagnostics, new vaccines and use of bio control agents. It thus provides effective tools for enhancing and sustaining food security and poverty alleviation. Excellent prospects exist for improving health and nutrition. Recent developments in stem cell research and human genome sequencing has opened new potentials for application of modern biotechnology for human welfare. Biotechnology promises improvement of livelihood of low income community by engineering nutritional quality of food, bioremediation and genetic conservation.

1.2. International developments related to Biotechnology

A number of developments have taken place over the past couple of years in the field of biotechnology applications. United Nations Conference on Environment and Development (UNCED), 1992 brought the issue of biodiversity conservation before the world community. The Convention on Biological Diversity adopted in 1992 covered issues related to biodiversity and biotechnology. Cartagena Protocol on Biosafety adopted in 2000 provided adequate level of protection in the field of safe transfer, handling and use of living modified organisms (LMOs) resulting from modern biotechnology avoiding adverse impacts on biological diversity and risks to human health. Conclusion of Agenda 21 (Chapter: 16 on management of Biotechnology); Millennium Development Goals (MDGs) adopted by the United Nations in 2000; Johannesburg Plan of Implementation adopted in the World Summit on Sustainable Development (WSSD), 2002; Water, Energy, Health, Agriculture and Biodiversity (WEHAB) initiatives of UN in 2002 and similar other developments have been instrumental in drawing attention of the world community on issues related to judicious use of biotechnology for human welfare.

1.3. Status of Biotechnology in Bangladesh

While other countries including our neighbours have made or are making impressive progress in biotechnology, Bangladesh has not yet made much headway in this field. Some work has been initiated using the techniques of genetic engineering for the improvement of plants, animals, industrial micro-organisms and also to combat environmental pollution problems.

The programme on plant biotechnology in Bangladesh was initiated in late 1970s which within 10-12 years spread to a number of research laboratories, in different universities and R & D organizations. Presently a few NGO's are also working on plant tissue culture. Protocols on plant regeneration and micro propagation have been developed on different crops, forest plants, ornamental and fruit trees as well as vegetables. Some work has been initiated on Agrobacterium mediated genetic transformation of rice, jute, oil seed, potato, chickpea, papaya for insect, fungus and virus resistance; genetic transformation of pulses for fungus resistance, salinity and drought tolerance; and nutritional enrichment/improvement. Marker aided selection and molecular characterization by RAPD, RFLP, micro satellite and isoenzyme studies are going on in different plants, fish and animal species. Research on use of DNA probes for the diagnosis of diseases; development of food, fibre and energy through recombinant DNA technology and DNA fingerprinting of rice, jute and some other crops is in progress.

In Animal Biotechnology, modern biotechnology programmes including Embryo Transfer Technology, Multiple Ovulation Embryo Transfer and Artificial Insemination programme have been initiated. Recently vaccine has been developed against goat plague. Developments in fish Biotechnology include induced breeding techniques in Carp, Pabda, Catfish, Koi and others; genetic stock improvement of

indigenous and exotic carp and tilapia through selective breeding; production of all monosex population (all males and all females) in tilapia and silver carp by sex reversal and chromosome manipulation technique; detection of introgressed hybrids in carps in the hatcheries using micro satellite DNA markers; stock discrimination of hilsa by allozyme and DNA-RFLP markers. In the field of Industrial Biotechnology Bangladesh is yet to make real breakthrough. Some achievement has been made in the field of biogas production from animal excreta (cow dung) and bioconversion of agricultural residues to feed, food and fertilizers. In case of Environmental Biotechnology, mostly traditional techniques are being used for waste treatment and pollution control. Modern biotechnological methods are yet to be applied.

2. VISION

The last part of the 20th century has witnessed spectacular progress in the fields of biotechnology and information and communication technology. Such advances have had a beneficial impact on food and health security. The tools and techniques of biotechnology will be used for poverty alleviation, health, nutrition and livelihood improvement, and conservation of environment. National capacities on all areas of conventional and modern biotechnology, biodiversity and biosafety will be developed to achieve world class competence in biotechnology.

3. GOALS AND OBJECTIVES

3.1. Goals

The main goal of the policy is to ensure sustainable development of agriculture-food and other crops; nutrition; health; environment and livelihood of people, enhance agricultural competitiveness in relation to global standards. The other important goals include strengthening of the national capabilities in modern biotechnology, biosafety, and bioethics in order to ensure judicious use of this modern tool for socio-economic development of the country. To that end the draft National Biotechnology Policy has been formulated with the following objectives.

3.2. Objectives

3.2.1 To harness judiciously the opportunities of biotechnological applications for enhanced productivity, increased quality and value of products leading to sustained food security, poverty alleviation and health and livelihood improvement.

3.2.2 To take up a detailed inventory of bio-resources in the country in order to promote conservation of biodiversity and sustainable exploitation of bio-resources.

3.2.3 To create congenial environment for encouraging R&D in biotechnology and allied fields through development of infrastructure and through appropriate incentives and regulatory framework for research in modern biotechnology.

- 3.2.4** To develop high quality infrastructure with required support services to encourage setting up of Biotech Parks in different places based on the availability of bio-resources.
- 3.2.5** To focus on human resource development in different areas of biotechnology.
- 3.2.6** To develop bioinformatics and related ICT facilities for rapid development of biotechnology.
- 3.2.7** To create enabling environment for the growth of biotech industries.
- 3.2.8** To facilitate flow of venture capital funds and bank credit to emerging local biotechnology companies.
- 3.2.9** To address issues such as Intellectual Property Rights, Biosafety, Biodiversity, and Bio-ethics with due emphasis on knowledge, innovation and practices of indigenous and local community.
- 3.2.10** To create public awareness on Biotechnology by involving all stakeholders to ensure adequate level of protection in the safe handling of this technology

4. OPPORTUNITY AREAS OF BIOTECHNOLOGY IN BANGLADESH

Biotechnology is a frontier technology which has the potential to provide substantial benefits to the society in a wide range of sectors such as agriculture, medical and health and nutrition, forestry, animal husbandry, fisheries and livestock, environment protection and improving the quality of products and services. The opportunities in Biotechnology are enormous and multi-faceted with respect to diversity and market value. However, for Bangladesh the areas of national interest include Agriculture-Food and other crops, Livestock and Fisheries, Forestry and Environment, Health Care and Nutrition, Biodiversity Conservation and other Biotech Products and Processes.

4.1. Agriculture-Food and other crops

The main policy goal of biotechnology is to enhance food security, poverty alleviation and health and livelihood security. While biotechnology can not solve all the problems associated with agricultural production, it has the potential to address specific problems like increasing crop productivity; diversifying crops; enhancing nutritional value of food; reducing environmental impacts of agricultural production through development of crop resistance to biotic and abiotic stresses and promoting market competitiveness. Agricultural-food and cash crops, vegetables, fruits, medicinal plant, flowers and ornamental plants etc. have immense possibility for improvement through application of biotechnology. In addition other important areas with opportunities include biofertilizers, biopesticides, herbal plants, animal feeds, diagnostics and development of post harvest technology to minimize loss of agricultural produce.

4.2. Fisheries and Livestock

The present level of fisheries and livestock production can be significantly improved through application of classical breeding and modern biotechnology for improvement of breeds and nutrition, protection of health and conservation of genetic resources of fishes and animals. In addition feed development and microbial upgradation, improved digestibility and bioavailability can be addressed through gene base technology.

4.3. Forestry and Environment

Bangladesh has a rich heritage of biological diversity in natural forests. Some of the opportunity areas in forestry include forest resource management, cash crop development, agro forestry, in situ and ex situ conservation of forest resources and improvement of economic forest plants by the application of modern biotechnology. In environmental sector development of efficient activated sludge processes for waste treatment, microbial strain development for waste management, bioremediation, effluents and waste water treatment, creation of value added products from waste (generation of compost and energy) are some of the opportune areas worth application.

4.4. Health care and Nutrition

In the health care and nutrition sector there is tremendous scope for development of therapeutics including herbal medicines, diagnostic kits, vaccines including edible plant vaccines and other medical products and tools for research, industries and medical teaching; introduction of genetic diagnosis, therapy and research including stem cell research and application and export of high quality medical biotech workers, teachers and scientists.

Medical biotechnology sector is closely related to human health and nutrition. This sector also has the most promising and potential future with respect to improving health and nutrition and earning foreign exchange. There is a great opportunity for development of medical biotechnology sector in this country.

4.5. Biotech Products and Processes

There are a number of opportunities in biotech products and process development. Food and industrial enzymes (protease, amylase, lipase, dextrinase, and enzyme cocktails), biopolymers, additives, classical microbial products like organic acids (citric acid, lactic acid, amino acid etc), antibiotics, vaccines, vitamins etc. have good internal market and export potentiality.

4.6. Biodiversity Conservation

Biodiversity conservation is an essential element of human development and security. Agriculture, forestry, fisheries and Livestock contribute significantly to national economies and employment. Achieving development goals requires creative

use of both existing and new resources. Bangladesh being one of the world's richest biodiversity zones/areas there is ample opportunity for developing this field.

5. POLICY STATEMENTS

In order to keep pace with the fast advancing field of modern biotechnology and achieve world class competence in different areas of biotechnology and create enabling environment for modern biotechnology research, development extension and commercialization, appropriate measures will be taken for infrastructure and human resource development and creation of centres of excellence in identified priority areas of biotechnology based on national needs. Emphasis will be given on intellectual property rights, indigenous community knowledge, biosafety, biodiversity and other related issues in order to ensure safe and judicious use of this technology.

5.1. Human Resource Development

Keeping in view the critical role played by the scientific and technical personnel in the development of biotechnology, all possible academic and training programmes in the field of biotechnology and bioinformatics will be encouraged.

5.1.1. Academic programme

The universities will be encouraged to introduce and strengthen biotechnology and genetic engineering at the undergraduate and postgraduate levels. The facilities in the universities and institutions will be strengthened. At the same time biotechnological courses will be introduced at the secondary and higher secondary levels through modification of existing course curricula on biology. Young graduates will be encouraged for undertaking higher academic studies in advanced Universities abroad. Local universities will be encouraged to develop sandwich programme with advanced laboratories abroad so that research work can be concentrated in areas of our national problem

5.1.2. Short and long term Training Programme for Researchers

Scientists and researchers working in different R&D institutions, universities will be provided short and long term training in specific field (techniques) in reputed institutions abroad so that on return they can train others to work in the said fields.

5.1.3. Orientation/Training for Policy Makers

Provisions will be made for orientation/training of policy makers and executives involved in signing biotechnology related Conventions, Protocols and Treaties in reputed institutions to facilitate their exposure to this new and emerging field.

5.2.4. Training of relevant stake-holders

Appropriate training programmes will be organized for all stake holders including farmers, extension workers and other professionals such as researchers, end users, clinicians, laboratory professionals about safe and judicious use of biotechnology.

5.1.5. Training on IPR

Keeping in view the importance of Intellectual Property Rights in biotechnology research scientists, entrepreneurs, legal personnel, policy makers, policy executives and Members of Parliament will be given special training on IPR in relation to Biotechnology applications in globally reputed institutions. A panel of qualified IPR experts will be prepared and trained to assist concerned scientists and investors on IPR issues.

5.2. Infrastructure Development

5.2.1. Optimum utilization of Biotechnology capacity

There are a good number of R&D laboratories scattered all over the country which are engaged at some low level of biotechnology research particularly on agriculture biotechnology. Measures will be undertaken to develop mechanism for coordination among these laboratories for optimum utilization of available facilities and to avoid duplication.

5.2.2. Strengthening of Biotechnology Laboratories

For front line research in modern biotechnology selected laboratories in some existing R&D organizations and academic institutions will be strengthened with modern laboratory facilities.

5.2.3. Creation of Centre(s) of Excellence

For an effective programme planning and undertaking cutting-edge research in modern biotechnology, creation of the Centre(s) of Excellence will be considered in selected areas of national interest (agriculture, forestry, health and nutrition, industry, environment) and will be housed in the places where advanced research is being conducted with international reputation.

5.3. Identification of priority areas of Biotechnology Research and Development

Biotechnology is a dynamic and multidisciplinary subject where the knowledge of many branches of science is being utilized globally for the practical benefit of human being. There are many programmes which will be equally important for the country. In view of certain areas of interest for the socio-economic development of the country some priority areas with programmes have been identified as follows.

5.3.1. Plant Biotechnology

- 5.3.1.1** Generation of transgenic crops/agro-forestry plants with improved traits.
- 5.3.1.2** Use of molecular markers to (i) tag genes of interest, (ii) accelerate breeding through marker-aided selection.

- 5.3.1.3 Undertake molecular characterization (DNA fingerprinting) of cultivars, landraces, and germplasm stocks.
- 5.3.1.4 DNA-based diagnostics to monitor / control / manage / eradicate pests and pathogens of crops.
- 5.3.1.5 Plant tissue culture for large scale multiplication of elite/disease-free planting material.
- 5.3.1.6 Biotech applications for development of biopesticides, biofertilizers and bio-remediation agents

5.3.2. Animal Biotechnology

- 5.3.2.1 Characterization, conservation and Genetic improvement of domestic animal resources through application of classical breeding and reproduction technology like multiple ovulation and embryo transfer technology (MOET) and modern gene based technology.
- 5.3.2.2 Diagnosis of animal diseases and molecular characterization of pathogens.
- 5.3.2.3 Biotech-derived therapeutic/diagnostic kits, drugs, antibiotics and vaccines for animal husbandry.
- 5.3.2.4 Improvement of animal nutrition by application of modern feed biotechnology for efficient use of crop residues, ensilaged feeds and forages and oil cakes.
- 5.3.2.5 Farm nutrient recycling for efficient farm waste management.

5.3.3. Fish Biotechnology

- 5.3.3.1. Development of improved strains through selective breeding.
- 5.3.3.2. Development of monosex population (all male or all female) using both sex inversion and chromosome set manipulation techniques.
- 5.3.3.3. Production of genetically manipulated sterile fish.
- 5.3.3.4. Development of Quantitative Trait Loci Specific (QTLs) molecular marker and marker-assisted selection for all major cultivated species.
- 5.3.3.5. Production of transgenic fish for enhanced growth and disease resistance.
- 5.3.3.6. Characterization of all the important fish and shrimp species using suitable molecular markers including microsattelite markers.

5.3.3.7. Development of cryogenic gene banking for conservation of improved strains and threatened species.

5.3.3.8. Development of PCR based molecular technique for rapid and effective diagnosis of infectious diseases.

5.3.3.9. Development of genetically engineered vaccines against devastating fish/shrimp pathogens.

5.3.3.10. Production of probiotics and metabolites for fish feed supplementation.

5.3.4. Medical Biotechnology

5.3.4.1. DNA-based diagnostics for the identification of both genetic and infectious disease.

5.3.4.2. Genetic counselling for patients at risk of acquiring a genetic disease and to would be parents who are at risk of giving birth to babies with medical disorders.

5.3.4.3. Genome sequencing on disease causing microbes and viruses endemic to Bangladesh for better therapy and prognosis through appropriate drug targets and vaccines.

5.3.4.4. Research to enhance the efficacy, product cost-effectiveness of molecular medicines.

5.3.4.5. Pharmacogenomics programme on Bangladesh's human genome diversity for the validation of drug targets.

5.3.4.6. Biotech pharmaceutical products including medicinal plants, vaccines and laboratory kits and tools for local use and export.

5.3.4.7. Medical biotechnology research including stem cell research and application.

5.3.5. Industrial Biotechnology

5.3.5.1. Production of enzymes and other chemicals of industrial importance.

5.3.5.2. Substitution of plastic through development of biodegradable plastics.

5.3.5.3. Development of value added products from plant, fishes and animals.

5.3.5.4. Development of pilot plant facilities for biotech product and processes.

5.3.5.5. Development of techniques for the production of single cell protein (SCP).

5.3.6. Environmental Biotechnology

5.3.6.1. Bioremediation of pollution in ground water and other effluents.

5.3.6.2. Development of microbial strains for waste management.

5.3.6.3. Development of biosensors for detection of lead, arsenic and other pollutants.

5.3.6.4. Evaluation of ecological impacts of transgenic organisms.

5.3.7. Biodiversity Conservation

5.3.7.1. Characterization of all available plants, fishes and animal species at the molecular level.

5.3.7.2. Assessment of production potential of plants, fishes and animals and their ability to resist disease and environmental stresses.

5.3.7.3. Preservation, development and long term conservation of bioresources.

5.3.7.4. Promotion of sustainable biodiversity management for poverty alleviation and quality livelihood.

5.3.8. Human Genetics and Genomics

- 5.3.8.1** Genome sequencing of Bangladesh population to determine the variation at the DNA level compared to that already sequenced for other population.
- 5.3.8.2** Characterisation of Single Nucleotide Polymorphism(SNP) for pharmacogenomic study for drug validation.

5.3.9. Bioinformatics

- 5.3.9.1** Generation of national level resource strength in bioinformatics.
- 5.3.9.2** Development of quality human resource in bioinformatics.
- 5.3.9.3** Application of bioinformatics in different biotechnology work in agriculture, health and environment.

5.3.10. Bio-safety and Bioethics

- 5.3.10.1** Development of guidelines and framework for biosafety and bioethics in relation to application of modern biotechnology for human welfare.
- 5.3.10.2** Establishment of linkage between the biosafety guidelines and the Biotechnology policy to ensure safe handling, storage, movement and introduction of genetically engineered organisms and overall improvement of biotechnology.

5.3.11. IPR related issues

Development of appropriate mechanism for protection of ownership of intellectual property, royalty to inventors, patent facilitation and protection of indigenous intellectual property rights.

5.4. Funding

- 5.4.1** Allocation of core funding for biotechnology research and development will be ensured and international support for R&D facilities and human resource development will be explored.
- 5.4.2** Self reliance and sustainability in R&D organizations and academic institutions through income generation based on innovative biotech products and processes will be encouraged.
- 5.4.3** Provision will be made for proper incentives to scientists involved in development of biotech products and processes of commercial importance.
- 5.4.4** Public- Private Partnership for growth of biotechnology industries and international collaboration in this regard will be encouraged.

5.5. Enabling Environment for Biotechnology Enterprise

- 5.5.1** Establishment of biotechnology enterprise zone (Bio-Valleys) for proper utilization of bioresources for development of biotech products.
- 5.5.2** Establishment of biotech entities combining R&D organizations, service providers as well as entrepreneurs for commercialization of biotech products and creation of network among the stakeholders.
- 5.5.3** Creation of **Biotech Incubator Parks** in collaboration with experienced foreign organizations with focus on agriculture-food and cash crop, medical biotechnology including herbal medicine and industrial products having market demand at home and abroad.

5.6. Commercialization

- 5.6.1** Creation of commercial wing in biotechnology research organizations to facilitate commercialization of research results.
- 5.6.2** Simplification of procedures for approvals and clearances for commercialization of any new biotech product and process.
- 5.6.3** Encouragement, incentives and impetus to the private entrepreneurs for commercialization of research findings.

5.7. Management of Intellectual Property Rights

In biotechnology research, problem arises concerning the protection of intellectual property for innovations in this field beyond legal and ethical questions. In view of the special quality of living organisms, the scope of patents has to be clearly defined to find a balance between innovator and public interest. Appropriate legal measures will be taken to achieve a balanced system for protecting the interest of the innovator without compromising public interest.

5.8. Indigenous Community Knowledge Protection

Indigenous community knowledge, collective innovations and community rights will be ensured through enactment of the **Community Knowledge Protection Act** to guide, inform, determine, control and give effect where necessary to rights and privileges to innovations of any form that have used natural and biological resources including traditional knowledge and culture of the country.

5.9. Biosafety and Bio-ethics

- 5.9.1** Management of opportunities and challenges of biotechnology viz. productivity, sustainability, biosafety, access, benefit-sharing and trade be ensured through appropriate mechanism.

- 5.9.2** Guidelines, acts and regulations will be formulated for development and management of biotechnology, biosafety, bioethics, biodiversity & environment protection to ensure human rights as well as social, cultural, ethical and economic perspectives of the country.

5.10. International Collaboration

Encouragement of bilateral and multilateral collaboration of the local R&D organization with advanced laboratories of the world will be encouraged to gain access to cutting-edge research in this emerging field and for training, expert service and facility development in areas of national interest.

5.11. Public Awareness measures

- 5.11.1** Arrangements will be made for non formal educational programmes for the purpose of public awareness about biotechnology and genetic engineering.
- 5.11.2** Regular seminars, dialogues and conferences will be organized involving civil society for the sake of transparency in biotechnology work.
- 5.11.3** Open public debates on the benefits and risks of this technology will be arranged for the sake of transparency in its application. Newspapers and periodicals will issue special supplement to inform the public about biotechnology in general as well as specific areas of Biotechnological Research and application in the country.

6. IMPLEMENTATION AND MONITORING/INSTITUTIONAL MECHANISM

6.1 Immediate action programme for the development of Biotechnology in the country in various sectors like Agriculture, Health, Industry and Environment will be chalked out which will reflect the urgent national needs and requirements in terms of funding, manpower and equipment etc.

6.2 For the effective implementation of the National Policy on biotechnology, a National Task Force has been formed with the Hon'ble Prime Minister in chair. It is responsible for generating and allocating need-based resources for operating and undertaking various activities through funding support from the government and possible foreign assistance. This Task Force will function as the highest policy making body who will give necessary directives for the development of biotechnology in the country.

6.3 The National Executive Committee, headed by the Principal Secretary to the Prime Minister will be responsible for implementation of the National Policy on Biotechnology to ensure speedy as well as risk free development of the technology as per directives of the National Task Force. The NECB will give approval to different projects submitted by respective ministries in the light of policy objectives and

programmes in different sectors of national economy. The NECB will devise a highly transparent and efficient mechanism with a positive and careful outlook for the development of this new branch of Science. It will also take the responsibility of winning the confidence and trust at all levels i.e. public, media and politicians etc. The National Authority on Biotechnology will act as an umbrella of the other regulatory authorities in the respective ministries.

6.4 Priority Plan

A Priority Plan in different areas of biotechnology will be developed by the Ministry of Science and Information & Communication Technology so as to keep pace with the fast advancing field of biotechnology and genetic engineering for poverty alleviation, sustainable development, improvement of quality of life and biodiversity conservation. This plan will highlight the national requirements and objectives with respect to priority programmes, institutional and manpower development and funding requirements.

7. POLICY UPDATING

Ministry of Science and Information & Communication Technology will periodically review (preferably every three years) the National Policy on Biotechnology in consultation with other relevant ministries for updating, harmonization and standardization of the policy in line with the fast development in this field and also with the international treaties; protocols; conventions etc. and submit recommendations to the NECB for consideration.

8. GLOSSARY

Definition of Terms.

Allozyme: Alternative enzyme forms encoded by different alleles (alternative form of a particular gene) at the same locus (position).

Artificial Insemination: The insemination method which is done artificially with preserved semen from the male without the involvement of sexual activity.

Biodiversity: The diversity or different forms of life-plants, animals and microorganisms present on the earth surface.

Bioethics: The branch of ethics, philosophy and social commentary that deals with the life sciences, particularly biotechnology development and their potential impact on society.

Bioinformatics: The use and organisation of information of biological/molecular biological interests through application of Information and Communication Technology (ICT). The information includes data acquisition, analysis and data base development.

Biopolymers: The different types of large molecules formed by living organisms including nucleic acids, proteins and lipids.

Bioremediation: The use of biological systems, usually microorganisms to clean up a contaminated site (environment).

Biosafety: The policies, regulations and procedures adopted to ensure the environmentally safe applications of biotechnology.

Biosensors: The devices that use a biological element (enzyme, DNA probe, micro organism etc) as an intimate part of a sensor.

Biosurveillance: The surveillance of Biotechnology developments in order to detect any harmful effects on the environment.

Biotechnology: The Application of tools and techniques using biological systems or derivatives thereof, to make or modify products or processes for desired use.

Cartegena Protocol: The International Protocol on Biosafety adopted in the year 2000 for safe transfer, handling and use of GMOs/LMOs resulting from modern biotechnology to avoid adverse impacts on biological diversity and risk to human health.

Cell: The structural and functional unit of a living organism. The smallest component of life.

Chromosome: The thread like structures of genetic material found inside the nucleus of a cell more obviously during the cell division stage.

Containment: Act of restricting or preventing the spread, leak or escape of an experimental object.

Diagnostics: A chemical, buffer, enzyme, antibody preparation etc. that is used for the purpose of diagnosis of diseases.

Diagnostic Kit: A package that contains all the required reagents in suitable form to carry out one or more specific assays for the detection or diagnosis of a disease or malignancy.

DNA Fingerprinting: The technique in which the banding pattern of DNA fragments is compared with that of known DNA to indicate relatedness.

DNA Probe: A short length of DNA of known sequence or origin that is labeled with a radioactive substance in such a way that it can be subsequently recognized.

DNA Sequencing: Determination of the order of bases in a DNA molecule.

Embryo Transfer Technology: It is a method by which embryos are collected from a donor female and transferred to a recipient female, which serves as a surrogate mother for the remainder of pregnancy.

Environment: Humans and their surroundings including living and non-living things, and also other factors like temperature and light intensity.

Enzyme: A protein that accelerates a specific bio-chemical reaction, without itself being destroyed.

Ex Situ Conservation: Maintenance of genetic resources outside of their original habitats in facilities such as gene banks and botanical gardens.

Gene: The fundamental physical and functional unit of heredity-the portion of a DNA molecule that is made up of an ordered sequence of nucleotide base pairs which produces a specific product or has an assigned function.

Genetic code: The code that translates information contained in messenger RNA into amino acids. Different triplets of bases (called codons) code for each of 20 different amino acids.

Genetic Conservation: Conservation or **in situ** preservation of genetic species-plants or animals prevailing on the surface of earth.

Genetic Engineering: The scientific techniques or methods used to isolate genes from an organism manipulate them in the laboratory and insert them into another organism.

Genetic Transformation: The genetic modification induced in an organism by the incorporation of DNA purified from other cells or organisms.

Genome: The total genetic make up of an individual plant or animal species.

Germplasm: The total genetic variability, represented by germ cells or seeds, available to a particular population of organisms.

GMO/LMO: GMO means a Genetically Modified Organism/LMO-means Living Modified Organism. These are living organisms whose genetic material has been altered or modified by any of the varieties of techniques of modern molecular biology to make them capable of producing new substances or perform new functions.

Golden Rice: Rice variety developed through Genetic Engineering in which genes for beta-carotene precursors have been inserted taking from daffodil plants. Eating such rice grains will help in overcoming vitamin-A deficiency causing night blindness.

Hybrid: An offspring of a cross between two genetically unlike individual plants or animals.

In Situ: In its original place or position.

Intellectual Property: That area of the law involving patents, copyrights, trademarks, trade secrets and variety protection.

Intellectual Property Rights: The Rights and Privileges enjoyed through Intellectual Property, Laws & Regulations.

Isoenzyme/Isozyme: The different species of the same enzyme that catalyze a biochemical reaction.

Marker: An allele (any of one or more alternative forms of a given Gene) whose inheritance is under observation in a cross.

Micro Satellite: The very short end segment of a chromosome that is separated from the rest of the chromosome by a secondary constriction.

Microbes: Small organisms or Microorganisms.

Micropropagation: The propagation of large-scale culture of cells or tissues to full grown plants.

Multiple Ovulation Embryo Transfer: The Embryo Transfer Technology in which more than one embryo is employed/utilized.

Organism: A living being (active or dormant stage of life)-a plant, an animal or microorganism.

Pathogen: A disease-causing organism.

Pest: A disease causing organism often applied to one that causes disease or attacks agricultural crops.

Pharmacogenomics: The genomic studies of pharmacological agents.

RAPD: Random Amplification of Polymorphic DNA-A method to detect the variations in DNA sequence through amplification of DNA and subsequent enzymatic digestion and analysis.

Recombinant DNA (rDNA): A DNA molecule into which a foreign DNA has been inserted.

Recombinant DNA Technology: The application of genetic tools - enzymes like restriction endonucleases, ligases, plasmids for the production of specific proteins by biological 'factories' like bacteria.

RFLP: Restriction fragment length polymorphisms-fragments of differing lengths of DNA that distinguish individuals produced by cutting with restriction enzymes. They result from variations in the DNA sequence and can be detected with radioactive probes and can be used as markers in breeding.

Satellite DNA: Eucharistic (Species having true Nucleus) DNA that band at a different density than that of most cellular DNA upon centrifugation.

Stem Cell: A Cell from which other cells stem or arise by differentiation.

Therapeutics: The treating or curing of a disease.

Tissue culture: The growth of cells, tissues or organs in suitable media in a laboratory environment that has strict sterility, temperature and nutrient requirements.

Transformation: Introduction, assimilation and expression of DNA from one organism to another.

Transgenic Crops: A Crop plant whose hereditary DNA has been augmented by the addition of DNA from a source other than parental germplasm in a laboratory using recombinant DNA techniques.

Vaccines: A suspension of weakened or killed virus or any other pathogen which when injected into the body of a susceptible host, immunizes the latter against the same type of pathogen or even against their toxins.