Biotech policy-

Biotechnology is a broad term used to describe a group of technologies based on the application of biological processes. It involves the use of living organisms or parts of living organisms to generate new processess or products and to find ways to improve the quality of life through diverse applications in medicine, agriculture, industry, energy and environment management. The term biotechnology includes the traditional biotechnological processes used for centuries in the manufacture of bread, alcohol, wine, beer, fermented milk products and some medicines, as well as modern biotechnology that involves amongst others, recombinant DNA technology, genomics, proteomics and bioinformatics. Biotechnology has made rapid strides as knowledge based industry during the last two decades contributing to the global economy in agriculture, healthcare, social wellbeing and environmental management. Technology and innovations make a major contribution to enable a country to improve competitiveness and productivity resulting in a higher standard of living and better quality of life for its people. It offered, significant opportunities for both industrialized and less industrialized countries to address social and economic problems such as poverty alleviation, job creation, food security etc.

International Scenario

Biotechnology, globally recognized as a rapidly emerging and far-reaching technology, is aptly described as the “technology of hope” for its promising of food, health and environmental sustainability. Biotechnology has grown rapidly in the 1990s, with a revolution taking place in the field; scientific discoveries have opened up new applications in health care, agriculture, food production, and environmental protection and the technologies hold the promise of meeting fundamental food and health needs around the world. At the same time, biotechnology also raises important policy and societal issues and has given rise to broad public debate. Great diversity exists between countries with respect to their capacity to develop, apply, and regulate the new biotech products and services. These differences have become a source of tension in international economic relations. Consequently, biotechnology presents a new challenge for international law. At the international level, there is no single comprehensive legal instrument that covers all aspects of biotechnology or biotech products. However, a number of existing international agreements are directly relevant to biotechnology. Many international organizations have also undertaken the task of setting standards, in particular dealing with the impacts of biotechnology on health, the environment, agriculture, trade, ethical and socio-economic aspects. These organizations include the Codex Alimentarius, the World Health Organization (WHO), United Nations Food and Agriculture Organization (FAO), the United Nations Environmental Programme (UNEP), the United Nations Educational, Scientific and Cultural Organization (UNESCO) and the United Nations Industrial Development Organization (UNIDO), etc. The development of international agreements and standard and rule-making relating to biotechnology can be of assistance to many countries, in particular developing countries, in establishing appropriate biotech laws while, at the same time, promoting harmonization of national biotech regulations at international level. In the long run, the practices of biotech laws and agreements at

both national and international levels will subsequently contribute to the formation of international biotechnology law.

More: http://www.eolss.net/sample-chapters/c14/e1-36-13.pdf
More: https://www.bio.org/articles/2013-policy-principles-promote-biotechnology

National Scenario

The Indian biotechnology sector has, over the last two decades, taken shape through a number of scattered and sporadic academic and industrial initiatives. India is reorganized as a mega bio-diversity country and biotechnology offers opportunities to convert our biological resources into economic wealth and employment opportunities. Innovative products and services that draw on renewable resources bring greater efficiency into industrial processes, check environmental degradation and deliver a more bio-based economy. Indian agriculture faces the formidable challenge of having to produce more farm commodities for our growing human and livestock population from diminishing per capita arable land and water resources. Biotechnology has the potential to overcome this challenge to ensure the livelihood security of 110 million farming families in our country. The advancement of biotech as a successful industry confronts many challenges related to research and development, creation of investment capital, technology transfer and technology absorption, patentability and intellectual property, affordability in pricing, regulatory issues and public confidence. Policies that foster a balance between sustaining innovation and facilitating technology diffusion need to be put in place. There are several social concerns that need to be addressed in order to propel the emergence of biotechnology innovation in our country such as conserving bioresources and ensuring safety of products and processes. Government and industry have to play a dual role to advance the benefits of modern biotechnology while at the same time educate and protect the interests of the public. Wide utilization of new technologies would require clear demonstration of the new added value to all stakeholders.

The National Science and Technology Policy of the Government and the Vision Statement on Biotechnology issued by the Department of Biotechnology have directed notable interventions in the public and private sectors to foster life sciences and biotechnology. There has been substantial progress in terms of support for R&D, human resource generation and infrastructure development over the past decade. With the introduction of the product patent regime it is imperative to achieve higher levels of innovation in order to be globally competitive. The challenge now is to join the global biotech league. This will require larger investments and an effective functioning of the innovation pathway. Capturing new opportunities and the potential economic, environmental, health and social benefits will challenge government policy, public awareness, educational, scientific, technological, legal and institutional framework. The issue of access to the products arising from biotechnology research in both medicine and agriculture is of paramount importance. Therefore, there should be adequate support for public good research designed to reach the unreached in terms of technology empowerment. Both “public good” and “for profit” research should become mutually reinforcing. Public institutions and industry both have an important role in the process. The National Biotechnology Development Strategy takes stock of what has been accomplished and provides a framework for the future within which strategies and specific actions to promote biotechnology can be taken. The policy framework is a result of wide consultation with stakeholders – scientists, educationists, regulators,

representatives of society and others and reflects their consensus. It focuses on cross-cutting issues such as human resource development academic and industry interface, infrastructure development, lab and manufacturing, promotion of industry and trade, biotechnology parks and incubators, regulatory mechanisms, public education and awareness building. This policy also aims to chalk out the path of progress in sectors such as agriculture and food biotechnology, industrial biotechnology, therapeutic and medical biotechnology, regenerative and genomic medicine, diagnostic biotechnology, bio-engineering, nano-biotechnology, bio-informatics and IT enabled biotechnology, clinical biotechnology, manufacturing & bio-processing, research services, bio-resources, environment and intellectual property & patent law. Several state governments have enunciated biotech policies spelling out a comprehensive blueprint for the sector. It is, therefore, prudent to have a National Biotech Development Strategy that charts an integrated 10-year road map with clear directions and destinations. This is the time for investment in frontier technologies such as biotechnology. It is envisaged that clearly thought-out strategies will provide direction and enable action by various stakeholders to achieve the full potential of this exciting field for the social and economic well being of the nation.

Application of biotechnology in India

Biotechnology is one of the emerging technologies which have immense potential for a developing country like India. Biotechnology which is the industrial use of micro-organism, living plant and animal cells to produce substances beneficial to the people. Biotechnology encompasses the manufacture of antibiotics, vitamins, vaccines toxic waste disposal using bacteria etc. But the major areas of biotechnology applications are:

1. Agriculture

Biotechnology has revolutionized research activities in agriculture which include tissue culture in plants, creation of new transgenic plants, transgenic animals which eventually used as bio-reactors to produce drug from their milk, flood etc. Genetic engineering methods accelerate improvement in plants by increasing the diversity of gene pool. It has also helped in production of such plants which have short maturing period and high yielding varieties. Biotechnology has also helped to production of such plants that have potential to promote food production in adverse conditions like drought, salinity etc.

The transgenic plants may provide one or more characteristics of the following:

(a) Resistance to insects, fungi, bacteria and virus
(b) Highly resistant to herbicides, pesticides and other chemicals.
(c) Drought, resistance, flood resistance, Salinity resistance, etc.
(d) High productivity.
(e) Crop plants with improved quality.

Plant Tissue Culture:

It aims at the in-vitro culture of plants. It is very beneficial for agriculture.

(a) Clonal propagation helps in rapid production of commercially important plants and trees like timber trees, ornamental plants, orchids, fruits, rubber plants, etc.

(b) Production of somatic hybrids by hybridization of protoplasts compatible plant species. Such somatic hybrids have characters of both related species.

(c) Production of artificial seeds, etc.

2. Food and Beverage Industry

A number of microorganisms are used beneficially in the production of certain foods and beverages like cheese, wine curd beer, vinegar, etc. The underlying process behind such productions is fermentation Natural fermentation has played a vital role in human development and it is the oldest form of production of wine.

Fermentation may be defined as the process which involves the biochemical activity of microorganisms to produce an economically important product like food, beverages or pharmaceuticals. In other words, it is the use of microorganisms for production of commercial products. Natural fermentation is the part of traditional biotechnology.

Several modifications are also done in the genome of microbes by gene transfer methods to achieve better results and this is involved in modern biotechnology. The fermentation may be performed by yeasts, bacteria, molds or by combination of these organisms.

Yeasts are of primary importance in manufacture of bread, beer, wine and distilled liquors. Molds are important in the preparation of some cheeses and oriental foods A few fermented products are listed below along with the substrate name and the name of microorganism involved:

Product	Substrate	Microorganism
1. Beer	Barley malt	*Saccharomyces uvarum, S. cerevisiae*
2. Cheese	Milk	*Streptococcus lactis*
3. Ginger Beer	Sugar solution flavoured with ginger	*Saccharomyces pyriformis and Lactobacillus vermiformis*
4. Grape wine	Juice of grapes.	*S. cerevisiae, S. ellipsoides* (Also called wine yeast)
5. Idli	Rice & black gram mungo soaked and ground	*Leuconostoc mesenteroides, Streptococcus faecalis, Pediococcus cerevisiae*
6. Miso	Steamed polished rice mash	*Aspergillus oryzae, Saccharomyces rouxii*
7. Soy Sauce	Mixture of wheat bran, soybean flour or rice	*A. oryzae, S. rouxii, Bacillus subtilis*
8. Tempeh	Boiled soybeans without seed coat	*Rhizopus* spp.
9. Tofu	Paste of soaked soybeans	*Mucor* spp.
10. Vinegar	Juices of fruits or starchy vegetables	*S. cerevisiae, S. ellipsoides and Acetobacter*
11. Yoghurt	Concentrated milk	*Streptococcus thermophilus and Lactobacillus bulgaricus.*

Single Cell Proteins (SCP):

It is the term which designates the high protein food from microorganisms like algae, filamentous fungi, bacteria and yeast. Genetic engineering is used to select and produce the high protein content or desirable composition of food by improving the microbial strains. SCP is, actually, the total microbial biomass which is free from any type of toxins and contaminants.

It is high in protein content so it can be used to replace the conventional vegetable and animal protein sources. Bio technological approaches have been in use for the mass-cultivation of SCP by improving the source microorganisms.

Some such microbial sources are:

Algae:

Chlorella, Spirulina, Scenedesmus

Mushrooms:

Agaricus campestris; Morchella crassipes

Yeasts:

Candida utilis, Saccharomyces fragilis, Rhodotorula

Bacteria:

Pseudomonas, Cellumonas.

3. Environment

A clean environment is as important for us as better health and nutritious food. Environmental biotechnology promises to solve many problems related with pollution, waste disposal, etc.

i. Methods using organisms to breakdown the pollutants for e.g. the traditional septic tanks where domestic sewage is decomposed by bacteria.

ii. Genetically engineered microbes (GEM) are used for efficient treatment of industrial waste water.

iii. A greatly enhanced oil-eating bacterial strain i.e., Pseudomonas helps in the removal of oil-spills.

iv. Bioremediation of pollutants is an effective, simple and more practical method of removal of earth's pollution. Bioremediation means the utilization of biological organisms for reducing pollution or for the removal of environmental pollutants. The bioremediation of organic toxic pollutants is mainly based on the microorganisms and thus it is called as 'microbial bioremediation. On the other hand, the bioremediation of inorganic contaminants is carried by certain plant species and therefore it is termed as 'phytoremediation' (i.e., bioremediation by use of plants).

v. Growing plants with high metal absorbing ability can be a cheap and effective method to remove toxic chemicals from a particular land area.

vi. Most importantly, the production of biofuels is also a gift of environmental biotechnology for us.

4. Health care and Medicines

In medical field, the contribution of biotechnology is most frequent. It not only helps in the cure of diseases but also aids in detection and prevention of disease. It also helps in curing genetic disorders by means of gene therapy.

i. DNA probes and Monoclonal antibodies are used as tools for diagnosis of diseases.

ii. Many valuable drugs and antibiotics are also produced on large scale by using biotechnological processes.

iii. Human Insulin was the first therapeutic product to be made commercially by genetically engineered bacterium.

iv. Cloning of human leukocyte interferon gene, HepatitisB Virus gene, Human Growth Hormone (HGH) genes, etc. have also helped in the production of vaccines.

v. Gene therapy is the method of curing genetic diseases (or acquired diseases) by the replacement of an abnormal gene by a therapeutic gene. Diseases like Tay-sachs disease, Cystic fibrosis, etc. can be cured by gene therapy. Currently biotechnologists are also making trials for using gene therapy to cure tumors, cancers, etc.

The type of gene therapy which is done at the level of germ cells like sperms, or eggs is called as germ line gene therapy. In this type of gene therapy, the functional genes are introduced into the genome of germ cells.

The changes so occurred are passed on to the forthcoming generations also, i.e., the changes are heritable in case of germ line gene therapy. Other type of gene therapy is the somatic cell gene therapy. It involves the correction of genetic defects by introduction of therapeutic gene into the somatic cells of body. The changes so occurred are not heritable.

vi. Genetic engineering aids in the high speed and high quantity production of antibiotics by certain microorganisms.

A few important antibiotics and their sources are given below:

(a) Penicillin – *Penicillium notatum, P. chrysogenum*

(b) Streptomycin – *Streptomyces griseus*

(c) Aureomycin – *S. aureofaciens*

(d) Chloromycetin – *S. venezuelae, S. lavendulae*.

(e) Erythromycin – *S. erytheraeus*

(f) Griseofulvin – *P. griseofulvum*

(g) Oxytetracyclin – *S. rimosus*

5. Energy and Fuels.

Today oil is the major fuelling material but it is bound to run out in forthcoming years. Also, it causes a great amount of pollution. A substitute of it is being found in biofuels which are produced from the sources that are relatively clean and renewable.

i. Potential fuel crops can be genetically engineered so that they can grow at a faster rate and that also with a higher ratio of easily fermentable tissues.

ii. The microbes involved in fermentation can also be engineered for more efficient conversion of substrate into biofuel.

Biotechnology is contributing a lot to increase the acceptability of biomass, biogas. etc. as the commercially stable energy options for forthcoming time. The biomass of other biological wastes can be utilized for the generation of different forms of energy.
Biotechnology provides a number of advanced techniques for this purpose. For instance, the techniques of gene manipulations, improved varieties of plants for high yield, modified microbes, etc. makes it possible to explore renewable sources of energy.

There are certain plants which produce hydrocarbons and are called as petro-plants. e.g. *Hevea* rubber plant, *Calotropis procera, Euphorbia lathyris*, etc. Certain algae are also of immense use in production of biofuels. Biological agents like plants and microbes are modified biotechnologically and are then used to generate efficient fuels like biogas, bioethanol, biodiesel, bio hydrogen, etc.

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7. Other Industrial applications.

Microorganisms are of great importance for production of various substances having great scope in different industries. Microbial strains can be improved biotechnologically to get the desired product in sufficient quantity. For this purpose, the microbes can be improved using genetic engineering (recombinant DNA technology).

Different products of interest which are frequently produced in this manner are vitamins, enzymes, organic acids, amino acids, etc. Using genetic engineering techniques, it has become possible to obtain the mutants of microorganisms which can produce a much higher amount of product of interest than the natural ones.

Genetic engineering not only results into enhanced metabolite production but may also help in product modification, or producing a completely new product of interest.

Different uses of genetically engineered microbes (GEM) in various industries can be enlisted as follows:

(a) Vitamins like Vit. A, B, C, etc.

(b) Alcohols like Ethanol, Butanol, Amyl Alcohol.

(c) Amino Acids e.g. L-Glutamate, Glycine, L-Lysine, L-Valine, eta

(d) Antibiotics e.g. Penicillin, Tetracyclic Streptomycin, etc.

(e) Enzymes from fungi, bacteria, etc. e.g. L-amylase, lipase, penicillinase, protease, invertase etc.

(f) Bio fertilizers, Bio insecticides and Bio herbicides from biotechnologically improved bacterial, fungal, protozoan strains. These are of great benefit in agriculture.

(g) Extraction of minerals like copper, uranium from ores through leaching by using improved bacterial strains.

8. Forensic cases

The applications of biotechnology in forensic science involve mainly the DNA fingerprinting technique. It helps in the identification of the rapists, murderers, or any other criminals on the basis of the study of DNA isolated from blood stains, hair roots, semen, sweat, saliva or urine.

This technique also helps in solving the parentage disputes i.e., to find out the biological father of a child.

9. Conservation of Nature

For ex-situ conservation of plant species, the biotechnological approaches are used. The germplasm banks, seed banks, gene banks, etc. utilize the cryopreservation technique. Various tissue culture techniques are also employed for conservation of threatened species. Micro propagation helps in the rapid multiplication of endangered plant species.

10. Biofertilizers

Bio fertilizers are described as the microorganisms which are utilized as fertilizers for plants as they enhance the availability of nutrients like Nitrogen (N) and Phosphorus (P) to the plants. Another term used for bio fertilizers is Microbial Inoculants. A number of biological agents are being employed at large scale for the commercial preparation of bio fertilizers which include algae, bacteria and fungi.

So, we may define bio fertilizers as the microbial inoculants of bacteria, algae and fungi which increase the availability of nutrients like N, P to the plants and thus result into benefit of plants. The importance of bio fertilizers has been realized now and therefore a lot of efforts are being made by the government as well as private sector to encourage the use of bio fertilizers.

The microbial inoculants/bio fertilizers serve following advantageous aspects:

(i) These are economical.

(ii) Unlike chemical fertilizers, they are environment friendly.

(iii) Bio fertilizers do not damage the soil texture.

(iv) They not only provide nutrition to the plants but also help in enhancing the plant growth and yield.

On the basis of the type of nutrient provided by the bio fertilizers, they can be categorized as follows:

(a) Nitrogen Bio fertilizers:

These are the microbial inoculants which enhance the availability of nitrogen by fixation of atmospheric nitrogen. Examples of this category include Rhizobium, Azospirillum, Cyanobacterium, etc.

(b) Phosphatic Biofertilizers:

These are the bio fertilizers which are responsible to increase the availability of nutrient phosphorus to the plant by solubilizing the soil phosphorus. Bacteria like Thiobacillus, Bacillus, etc. are important examples of such category.

Some important microorganisms which are used commercially as bio-fertilizers are enlisted below:

Organism		Activity	Beneficiary crop
• **Bacteria**			
	Azotobacter	Asymbiotic Nitrogen Fixation	Sunflower, wheat, rice, tobacco, spices
	Azospirillum	Asymbiotic Nitrogen Fixation	Vegetables, maize, wheat, rice, sugarcane
	Rhizobium	Symbiotic Nitrogen Fixation	Legumes like oilseeds and pulses.
	Thiobacillus	Phosphate solubilization	Many vegetables
	Pseudomonas	Phosphate solubilization	Potato, radish, sugarbeet.
• **Cyanobacteria**			
	Nostoc	Asymbiotic Nitrogen Fixation	Rice
	Anabaena	Asymbiotic Nitrogen Fixation	Rice
	Anabaena-Azolla	Symbiotic Nitrogen Fixation	Rice
• **Fungi**			
	Glomus	Phosphate Solubilization (as mycorrhiza)	Coffee, cardamom

For large scale production of bio-fertilizers, it is choose the efficient strains for N_2-fixation and/or P-solubilization. To ensure the longevity of bio-fertilizers, their storage and distribution systems must be proper. In India, there is a continuous progress of bio-fertilizers exploitation.

A number of private industries are also involved in manufacturing of bio fertilizers. Government has also prepared a range of standards regarding the maintenance and quality of bio-fertilizers. A National Bio-fertilizer Development Centre is located at Ghaziabad in U.P. which functions for the quality check and development of bio-fertilizers in India.

10. Gene Bank:

A gene bank is a facility where the genetic material is stored in the form of seeds or plant parts at low temperatures. It serves as an efficient method to store the germplasm of wild as well as cultivated plants and therefore it helps in conserving the vanishing genetic-diversity.

A gene bank is actually like a compartmentalized cold storage where the genetic material is stored under controlled conditions of the temperature and humidity for their germplasm conservation. Conventionally **'seeds'** are preferred as the material for germplasm conservation. The principle of a gene bank is that the dehydrated seeds can retain their viability for a longer period of time if stored in cold conditions.

For a long-term storage usually a temperature ranging between 0-18°C is applied. However, cryopreservation has made it more easy to store seeds in viable condition for even longer durations of time. In cryopreservation, the genetic material is stored in liquid nitrogen having a very low temperature of -196 ^{o}C. Along with conserving the original genetic diversity, gene banks also make the genetic material available as raw material to the breeders and biotechnologists.

A few of the important gene banks are located at Vavilov Institute (Russia), National seed storage laboratory (Fort Collins, USA), International Rice Research Institute (Philippines), National Bureau of Plant Genetic Resources (New Delhi) and Royal Botanic Garden (Kew).

State wise Biotechnology Policy and regulation in India

Since the late 1980s, India has started to establish its policy and regulatory system for agri-biotech development, and the country is currently undergoing a serious push for changes. *The Rules for the Manufacture, Use, Import, Export and Storage of Hazardous Microorganisms/Genetically Engineered Organisms or Cells 1989* (which we will refer to as 'Rules 1989') is the first and fundamental set of regulations related to agri-biotech enacted under the Environment Protection Act (EPA) of 1986. Pending parliamentary approval of the Biotech Regulatory Authority of India (BRAI), India's policy and regulatory mechanism is still governed by the EPA 1986 and the Rules 1989. In this section, we briefly look at Indian biotech policy developments, which is considered as three stages: a) policy and regulatory establishment from 1989 to 2002 when Bt cotton was approved for commercialization; b) policy developments from 2003 to 2010 when the Ministry of Environment and Forests (MOEF) imposed a moratorium on Bt brinjal; and c) policy debates since 2010, during which Bt brinjal and BRAI are under suspension.

The growth of the Indian biotech sector has significant implications for policy and regulation development. Since 2002, when it approved Bt cotton for commercialization, India has undertaken a number of notable actions, including ratification of the Biosafety Protocol in 2003 and approval of a national biotech development strategy in 2007, which was an important guiding document for 10 years.

In addition to India's ratification of the Biosafety Protocol in 2003, there was an important report in 2004 commissioned by the Ministry of Agriculture (MOA) and MOEF to evaluate the regulatory framework for agri-biotech products. This *Report on the Application of Agri-Biotech* was chaired by M.S. Swaminathan, a geneticist renowned for his leadership and success in introducing and developing high-yielding varieties of wheat in India. The report recommended establishment of an autonomous, statutory, and professionally-led National Biotechnology Regulatory Authority (NBRA). This is the first time a national biotech authority had been proposed. According to the proposed NBRA, there would be two separate wings—one dealing with food and agri-biotech, and the other with medical and pharmaceutical biotech. The report asserted that NBRA is essential for generating the necessary public, professional, and

commercial confidence in the science-based regulatory mechanism in place in the country (Government of India, DBT, 2008).

In 2005, DBT published a draft of a National Biotech Development Strategy which elaborated a 10-year vision for the future of biotech in India. This would be achieved through a process of multi-stakeholder consultations that focused on cross-cutting issues of relevance to all sub-sectors of the biotech community. Under the topic of regulatory mechanisms, this document recommended the national biotech regulatory authority to be established with separate divisions for agricultural products/transgenic crops, pharmaceuticals/drugs and industrial products, and transgenic food/feed and transgenic animal/aqua culture. This authority is to be governed by an independent administrative structure with a common chairman (Government of India, Department of Science & Technology, 2005). In 2007, this National Biotech Development Strategy was approved by the Government of India.

Some states in India are interested in accepting biotech; others are cautious to this technology. Therefore, the agri-biotech policies and regulations differ from state to state. Generally speaking, the southern states, which cultivate a large amount of cotton, are inclined to accept agri-biotech. Given below states, have developed biotech policies since 2000 that promoted the agri-biotech development in their areas

Andhra Pradesh

Government of Andhra Pradesh has identified biotechnology as a key thrust sector for industrial development. The sector has tremendous potential to build robust knowledge base and foster innovation, research and development. Biotechnology Policy 2015-20 aims to enhance competitiveness of the sector and make Andhra Pradesh one of the most preferred destinations for biotechnology investments, attract new

More:https://www.apindustries.gov.in/APIndus/Data/Industry1/Andhra%20Pradesh%20Biotechnology%20Policy%202015-20.pdf

ASSAM

The primary aim of the Biotechnology Policy is to utilize biotechnology for socio-economic growth of Assam and for fulfillment of development goals with biotechnology as one of the key sectors.

Assam is one of the biodiversity hot spot regions and is very rich in plant, animal and microbial resources. It is considered as the genetic centre of origin of citrus and bananas. The state has vast species diversity as well as commercial strength in rice, tea, bamboo, rattan, jute, ginger, citrus and several other commercial crops. Several hundred species of medicinal and aromatic plants grow naturally in Assam, some of which are endemic to the State and highly valuable

commercially. The state is also rich in orchid and other ornamental plant species. The microbial resources of the state are enormous and have economic potential. Muga and Eri silk of Assam is a distinctive bio-based industry. Aquatic and forest bioresources are the other major engines for economic growth of the State. Biotechnology will offer excellent opportunities in augmenting value creation, wealth and employment not only in many of these areas but also lead in new vistas for application in agriculture, medicine and industry. The unique and vast bio-resource potential of Assam stands to provide tremendous economic benefit through commercialization of these resources using biotechnology. The natural resource based industries viz., petroleum, natural gas and coal also entail biotechnology intervention in terms of enhanced production, pollution control and several other aspects.

More: http://guwahatibiotechpark.com/userfiles/Draft%20Biotech%20policy.pdf

Chhattisgarh

Chhattisgarh along with being one of the largest states of India is also one of the richest in terms of mineral resources and biospheres in India, and is endowed with about twenty two varied forest types. These have naturally occurring varieties of herbs and shrubs, with proven medicinal and aromatic ingredients. We have over thousands of square kilometres of virgin forest that are yet to be scientifically surveyed. A wealth of varieties of indigenous rice as a source of unexplored gene pool occurs naturally. Established traditional knowledge systems of self- healing and nutrition that are based on knowledge of the Bio-wealth, is a unique feature of various communities of Chhattisgarh. The State provides good governance and excellent infrastructure for industries in biotechnology. Biotechnology has a key role to play for our future prosperity. Chhattisgarh is a biodiversity hotspot – and is thus well poised to assume a significant and leading place in the biotechnology sector. The State, given its strengths, would like to benefit from the present global advances in the field of biotechnology & bioinformatics. Given a facilitative environment Biotechnology as a scientific tool holds immense promise in areas as wide ranging as agriculture, health and communication. Biotechnology, broadly defined, includes any technique that uses living organisms, or parts of such organisms, to make or modify products, to improve plants or animals, or to develop microorganisms for specific use. Genomics has reached major milestones in cracking the code to life's biggest biological mysteries. Biotechnology is a broad field including several related disciplines, which are further translated to productive processes by coupling with such disciplines as chemical engineering, information technology and robotics. Biotechnology will play a key role in harnessing natural resources in an eco- friendly manner, for creating wealth, to make us globally competitive in an increasingly

technologically sophisticated world. The rapid advances in the field of biotechnology the world over, are taking place in an atmosphere that allows a larger participation of the industry and greatly driven by commercial interests. However, at the same time there are global arrangements in place in the form of Intellectual Property Rights (IPRs), Plant Breeders Rights (PBRs) and stringent regulatory issues, which would not only have to be adhered too but to also develop a mechanism within the overall international scenario to ensure custodial rights to local communities of Chhattisgarh. Chhattisgarh enjoys a unique position in the fields of agriculture, healthcare and sericulture for which we endeavour to bring technological advancement for the overall development of society. We have to look at a logical diversification in our crop-composition, along with an enhanced use of biotechnology products, which would also in the long run enable a better environmental protection and will ensure further growth and increased returns to farmers. Biotechnology as a tool has the potential to bring a sea change in the socioeconomic status of the people living in this region. The positive impact will usher in a new era of food grain production coupled with food-security, significant alterations in the field of animal husbandry and fisheries leading to economic prosperity, assurance of quality food products to the consumers along with environmental protection. In order to foster international cooperation, the nascent State of Chhattisgarh has the necessary drive and desire.

More: http://www.chips.gov.in/sites/default/files/BTPolicy.pdf

Goa

The Goa biotechnology policy is to ensure accelerated growth in all areas of this sunrise sector as education, research and economic sectors covering healthcare, agriculture, industry, services, environment management and employment generation so as to bring the State to a position of pre-eminence which it has been occupying in other sectors of social and economic growth. Therefore, the policy document identifies the factors required to ensure such growth and enumerates the steps to be taken by all the stakeholders including the Government in its various departments related to biotechnology such as Education, Agriculture, Health, Science and Technology, Environment and Industry; Institutions of higher learning such as the universities and research institutions, the industry, institutions of local self and Government at village level, farmers and the regulatory agencies.

More: http://www.goaditc.gov.in/biotech.html

Gujarat

Gujarat public policy is reflection of the state's resolve towards adoption of Biotechnology as a tool towards socio-economic development of the subjects of the state and shall act as the guiding

document in defining the priorities as also the strategy, though not the implementation methodology. The strategy shall cover various aspects including development of infrastructure, promoting research, encouraging technology development, Supporting Biotechnology education/ human resource development, boosting biotechnopreneurship and biotechnology business,
building public consensus towards the potentials and applications of biotechnology, reassuring biotechnology awareness.

More: https://btm.gujarat.gov.in/images/Draft-Biotech-Policy-16.pdf

Haryana

Haryana was in the vanguard of the green revolution: It is an agrarian state deriving 33% (199-200 quick estimates), of its annual income from the agricultural sector with 71% (2001 census data), of is population in the rural areas. At the same time, it is pertinent to note that it birders the capital Delhi on three sides, has large cities, is urbanizing at a fast pace, is a leading industrial state with the number of large & medium industries continuously growing. Several reputed companies in the field of biotechnology have already set up their enterprises/manufacturing units. With just 1.37% of the total geographical area and less than 2% of the country's population, it today is one of the leading States in the country in terms of per capita income. It enjoys the unique distinction of being the first in India to provide electricity, metalled roads and portable drinking water to all its villages. With this basic infrastructure already in place, it is in an ideal position to take full advantage of the new biotechnological revolution.

Thus the objectives of the State's policy naturally flow from its existing infrastructural facilities and resources to which can be added those from which results can be realistically achieved within a meaningful time frame.

More: http://documents.gov.in/HR/15233.pdf

Himanchal Pradesh

Upgrade infrastructural support to R&D institutions to generate highly skilled human resource in biotechnology. Intensify R&D work in potential areas of biotechnology, including agriculture, animal husbandry and human health. Conserve and commercially exploit bio-resources of the state for sustainable development. Attract entrepreneurs for setting up of biotechnology-based industries. Provide suitable institutional framework to achieve objectives

More: http://desthp.nic.in/pdf_docs/DraftBTPolicy2014_A1b.pdf

Jammu & Kashmir

Biotechnology is the new generation technology of hope for prosperity and growth of a country. Like everywhere in the world, it has added to the economy of our country. Many states such as Karnataka, Tamil Nadu, Gujarat, Maharashtra, Himachal Pradesh, and Punjab have exploited the use of this technology to their advantage advancement in employment generation, industrial development and consequently wealth generation but the state of Jammu and Kashmir has yet to

harvest the fruit of biotechnology. There is thus a great opportunity to improve the socio-economic status of J&K using the biotech engine. The state has also to create an environment to attract the investors in this sector. Though some measures such as creation of industrial belts, industry development policy, tax benefits and facilitating the supplies and utilities have been taken yet there is need to review the situation, draft a policy that sets the scene for biotechnology entry, shows the direction, identifies the thrust areas of work and also lures the investors for investing liberally in the state of Jammu and Kashmir.

More: http://jksandtcouncil.nic.in/Biotech.pdf

Karnataka

The State Government is committed to maintaining Karnataka's pre-eminent position in the biotechnology sector and has a comprehensive Biotech Policy. To attract investment in this sector, the State Government has outlined incentives for the biotechnology industry which include:

(1)Exemption on payment of entry tax on machinery, equipment, capital goods and construction materials

(2)Up to 50% exemption on payment of stamp duty and registration charges

(3) Concessions for biotechnology parks certified by the Department of IT and Biotechnology with a built up area of 50,000 sq ft.

Karnataka is also committed to providing the right infrastructure and enhancing human resources for the development of biotechnology. The Government has established the Institute of Bioinformatics and Applied Biotechnology in the International Technology Park in Bangalore. It also plans to establish a biotech park at the University of Agricultural Sciences in Bangalore. This park will house research organizations and companies. Some of the other institutions in the state that promote biotechnology are the Centre for Human Genetics, Institute of Agri-Biotechnology and Institute of Bio-Informatics and Applied Biotechnology. Karnataka has also set up a biotech development council and has a single-window agency to clear all biotech projects in order to encourage investment in the sector.

More: https://www.nriforumkarnataka.org/policy/Bio%20Technology%20Policy.pdf

Kerala

The BT policy for Kerala is designed to catalyse the development and application of BT, taking advantage of the State’s resources and emphasizing its specific needs while meeting global

requirements. The policy is aimed to ensure the rapid exploitation of pipeline technologies and opportunities available in the State to products and processes and to promote the sustained build-up of an elite knowledge cadre and knowledge base through the strengthening and creation of educational and R&D institutions, establishing infrastructure and putting in place administrative, regulatory, legal and financial framework conducive for investment and growth of BT enterprises, for the economic development and human welfare.

The specific objectives and goals are :

Create a biotech knowledge base and human resources by establishing world-class centres of education and R&D in biotechnology by upgrading existing institutions and/or organizing new entities in the public and private sectors (eg. on the lines of Birla Institute of Technology, Pilani).

Apply biotechnology tools to:

(1) Enhance the value with adequate assurance of quality in the State's export-oriented resources such as spices and related plantation crops, sea foods and marine resources;

(2) Upgrade productivity and evolve new application in rubber, coconut, tuber crops and develop novel internationally competitive products;

(3) Ensure the sustainable and eco-friendly exploitation of the State's forest, animal and marine wealth;

(4) Boost the State's renowned health care practices of Ayurveda by synergizing traditional knowledge with the scientific validation and technical product profiling and clinical data base and by evolving means to conserve and substantially use one of world's most-valued biodiversity treasures located in the State.

(5) Promote traditional tribal and ethnic knowledge in medicine and other areas of human welfare by scientific validation and facilitating intellectual property rights.

(6) Develop recombinant DNA and other modern technologies to combat the major health hazards of the State such as cancer, diabetes and cardio-vascular and other physiological disorders; to develop diagnostics and vaccines for overall healthcare as well as to protect the State's agriculture, spice, plantation and forest crops, from biotic and abiotic stresses.

(7) Enhance the quality of the environment and promote sustainable development;

(8) To create, coordinate and disseminate a data base encompassing the above cited areas;

(9) Provide an ambience with a package of guidelines for financial support and incentives, legal and labour reforms as well as institutional autonomies needed for the healthy, efficient and competitive growth of biotechnology knowledge base and industry.

More:

http://www.biotechcommission.kerala.gov.in/index.php?option=com_content&view=article&id=57&Itemid=63

Madhyapradesh

Development of Biotechnology and the spread of benefits through widespread use of its applications have emerged as one of the leading intellectual enterprises of the scientific community the world over. Biotechnology is research- led and capital intensive. It demands the supply of trained human resources. At the same time there are strengths emanating out of traditional wisdom that need to be protected and enhanced for the larger common good. Govt. of Madhya Pradesh has framed M.P. Biotechnology policy 2003 with the objectives of Forging an alliance between capital intensive research and modern knowledge on the one hand and traditional wisdom and practices on the other and promoting partnership between various stakeholders that include tribal and rural communities, local and state administrations, non-government organizations, scientific establishment and industry. State Government shall make efforts at the community and state levels to harness the potential of biotechnology for value addition in agriculture, horticulture, animal husbandry, fisheries, forestry and use of bio-fuels; and to improve the quality of life of the citizen by promoting health and nutritional security and through pollution abatement. To achieve these larger goals the state government shall expand opportunities in biotechnology education and research and take step to protect and expand the flow of benefits from traditional knowledge and practices.

Objectives:

- The board objective of the policy shall, inter-alia, include promotion of biotechnology applications for:
- Conservation of the state's Biodiversity and the sustainable use of its biotic resources.
- Production of high-yielding, drought and pest- resistant seeds for agriculture and horticulture crops suited to different agro-climatic zones.
- Improvement of the quality of livestock and poultry, especially the breeds indigenous to the state.
- Enhancement of the productive potential of the aquatic eco-system.
- Promotion of cultivation of medicinal and aromatic plants, and the processing and value addition of their produce.
- Production of cost effective drugs that help counter disease common in the tropical and sub - tropical regions of the country.
- Promote environmentally safe technologies for pollution abatement, especially treatment of urban waste and industrial effluents.
- Afforestation especially in the quick revival of species which have shown a tendency to decline.
- Generation and use of different types of bio-energy.

More: http://www.mpbdandbt.nic.in/bt%20policy%202-5-2003.pdf

Maharastra

The State of Maharashtra has always played a leadership role in the national economic and social renaissance. It has looked at advances in science and technology as great opportunities for bringing about economic transformation and social change. One great opportunity in this new century, rightly termed as the 'Century of Knowledge', is the emergence of knowledge-based industries. Information Technology (IT) was just a forerunner among these industries and Maharashtra responded rapidly and became a leading State in IT. Another emerging opportunity on the horizon is Biotechnology. Biotechnology deals with living systems, including plants, animals and microbes. Biotechnology derives its strength by harnessing biological processes that sustain life. It incorporates any technique, which uses living organisms, parts of organisms and enzymes, proteins, etc., which are either naturally occurring or are derived from such living systems. Such techniques can be used to make or modify the products, improve plant or animal productivity or develop microorganisms for special use. Emerging Biotechnology uses recombinant DNA, cell fusion, embryo manipulation, etc.
Biotechnology has the potential to transform the lives of the people in the State by impacting hugely on agriculture, animal husbandry, health, environmental protection, material transformation, etc. Further, Maharashtra has the potential to become a leader in Biotechnology, not only in the country but also in the entire world. It is to realize this potential that the State is announcing this Biotechnology Policy 2001.

More:

http://www.midcindia.org/Lists/Policies%20Circulars%20and%20Notification/Attachments/2/BioTechPolicy.pdf

Odisha

The Government of Orissa has already taken many initiatives for promoting biotechnology in the state. It had brought out the Biotechnology Vision Document in 2001 for the 10th five year plan. It has also declared biotechnology as a priority sector in its Industrial Policy Resolution (IPR-2001). These initiatives would be expanded and given major thrust as part of the Biotechnology Policy.

More: http://www.orissa.gov.in/biotechnology%20policy-2005-circulated%20copy.pdf

Rajasthan

Biotechnology Policy is in place to position Rajasthan as an attractive destination for biotech industry, to create and upgrade biotechnology infrastructure and to create a quality infrastructure for research and commercial activities. . The Policy provides various benefits to units setting up in biotechnology industry.

More: http://swcs.rajasthan.gov.in/Upload/bf209791-24f4-46eb-aee5-f8e6374089eebtpolicy2015.pdf

Tamil Nadu

The Vision 2023 Tamil Nadu unveiled by Honourable Chief Minister in March 2012 mentions Biotechnology sector as one of the Sunrise sectors and emphasises the need to create networks of scientific and research institutions focusing on areas such as biotechnology, high yielding varieties, tissue culture, etc. The Vision 2023 document further envisages the development of eleven important and special signature projects that will create a huge positive impact and provide significant spin-off benefits, one of which is the development of world class institutions of research and knowledge in the Biotechnology sector. Efforts are on to get a National Biotechnology Centre of Excellence established in Chennai. The Golden Jubilee Biotech Park, exclusively for women, is another pioneering effort of the State Government.

Though the growth of the biotechnology sector in Tamil Nadu has been quite impressive, it can be even better, especially given the abundant opportunities available and the favourable factors Tamil Nadu is endowed with. Hence, this revised Policy: to take a re-look at the journey undertaken so far, and to chart the future course of action to re-invigorate the sector.
Based on the recommendations of a High Level Committee under the chairmanship of Dr. M. S. Swaminanthan, the State Government announced a Biotechnology Policy in 2000. The details in the given link

More: http://www.investingintamilnadu.com/tamilnadu/doc/policy/Tamil_Nadu_Biotechnology_Policy_2014.pdf

Uttar Pradesh

The state Uttar Pradesh aspires to utilize the modern tools of biotechnology and attain prosperity for farmers, generate employment in rural areas, food for all, good health and clean environment. The mission of the policy is to develop knowledge-based economy, assure benefit of biotechnology to all section of the State and promote entrepreneurship in biotechnology-based industries.

More: http://www.cstup.gov.in/PDF/biotech-policy.pdf

Uttarakhand

Uttarakhand would benefit greatly from the direct intervention of biotechnological research, know how and associated tools for the sustainable development of the State and its economic

upliftment in tandem with the preservation of its fragile but unique ecosystems, environment and the rich biodiversity

More: http://deskuenvis.nic.in/pdf/Uttarakhand%20b%20t.pdf

West Bengal

The West Bengal Government recognizes the need for faster economic development in the state. Its strategy for encouraging investment and achieving higher levels of economic development based on the (1) Encouraging foreign technology and investment, as may be appropriate or mutually advantageous (2) Focus on industries where the state has a competitive advantage. (3) Maintaining balance between interests of industry & workers and Restructuring of public sector enterprises. Based on these approaches, the State Government has adopted biotechnology policies for long-term growth and development. The state has been putting efforts to facilitate the growth of biotech industries and development of clean biotech technologies. The various key initiatives under this section include:

- Conserve bio-diversity through mapping and sustainable use of bio-resources,
- Create a "Centre of Excellence for Biotechnology" as a high quality support service to Biotech Industries,
- Facilitate the flow of venture capital funds and bank credit to Biotech companies.
- Spread general awareness for optimum utilisation of Biotechnology in the agriculture sector,

More: http://www.indiaenvironmentportal.org.in/files/file/Biotechnology%20Policy%20-%20west%20bengal.pdf

Rules and Regulation

Biosafety concerns are leading to the development of policy and regulatory regimes in various countries for research, testing, safe use, and handling of genetically modified organisms (GMOs) and relevant products. India is one of the earliest countries to establish a biosafety system for regulation of GMOs. With respect to the policy and regulatory issues related to agri-biotech, India develops them based on its EPA from MOEF in 1986. MOEF enacted EPA, which is intended to protect and improve environmental matters.

Under the EPA, the *Rules for Manufacture, Use/Import/Export & Storage of Hazardous Micro Organisms/ Genetically Engineered Organisms or Cells* were ratified by MOEF on December 5, 1989, which are commonly known as the Rules 1989. The Rules 1989 provide the general policies and regulations for import, manufacturing, and other use of the GMOs, as well as products made by the use of such organisms. The rules also cover research as well as large-scale applications of GMOs and products made in India.[9]

Since the Rules 1989, the policy and regulations in India have been altered from time to time. During this period, the Department of Biotechnology (DBT) in the Ministry of Science and Technology (MOST) developed the rDNA Guidelines in 1990 and amended them in 1994. The rDNA Guidelines include measures for research and development (R&D) on GMOs, transgenic

crops, large-scale production, and deliberate release of GMOs, plants, animals, and products into the environment, shipment and importation of GMOs for laboratory research. The Guidelines for research in transgenic plants cover the areas of rDNA research on plants, including the development of transgenic plants and their growth in soil for molecular and field evaluation (US Department of Agriculture, Foreign Agricultural Service, 2012). Another important development was the DBT guidelines in 1998 for biotech plant research. These involve regulations around the import and shipment of biotech plants for research use.

Coordinated by DBT under the Rules 1989, India achieved a number of milestones in agri-biotech R&D during the 1990s. For example, since 1998, India's economic data has included biosafety evaluation criteria. In 2000, along with Indian companies, Monsanto received regulatory approval for large-scale trials for Bt cotton. In 2002, while unapproved Bt cotton was discovered in West India (Gujarat), a Monsanto-based company in India was granted Bt cotton commercialization (Pradhan, 2011)

Governance System

Like its economic system, India's agri-biotech regulatory governance is relatively independent. Three central governmental ministries—MOST (DBT), MOEF, and MOA—are involved in this governance, along with a number of risk-management institutions within or outside of these ministries (Figure). Since three ministries are involved in this governance, some different regulatory management is likely to be taking place among them. In the Indian federal-state system, there are several different bodies to manage agri-biotech in individual states. In addition to these differences, both central and state governments' regulatory measures might receive broad debates among different interest groups. In this section, we briefly look at India's major institutions that involve the agri-biotech sector, its governance framework, its approval process, as well as a proposed national biotech authority.

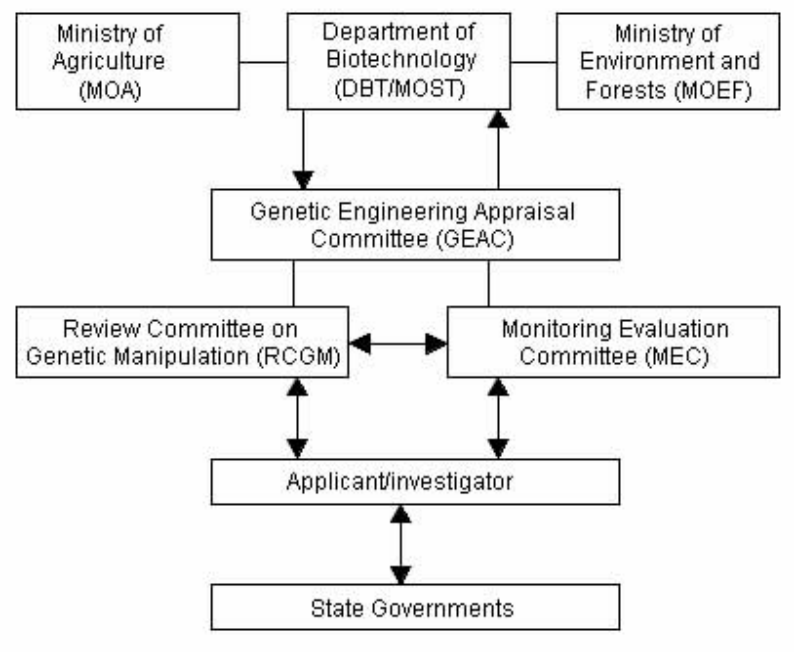


Figure: Biotech regulatory mechanism in India

Institution Players

In addition to the ministries involved in Indian agri-biotech research and commercialization, a number of other significant institutions at either the central or national level are involved in Indian agri-biotech review, assessment, and the approval process. These institutions are authorized to gather experts for overseeing agri-biotech research and commercialization in India. They are granted moderate independence to consider their own review process from different perspectives or fields. Let's briefly look at these institutions and their roles in terms of agri-biotech research and commercialization.

As discussed, GMOs and relevant products in India are regulated as per the Rules 1989 implemented by MOEF. These rules are enforced by both MOEF and DBT through the authorized institutions identified under the Rules, which mainly include rDNA Advisory Committee (RDAC), Institutional Biosafety Committee (IBSC), Review Committee on Genetic Manipulation (RCGM), Genetic Engineering Appraisal Committee (GEAC), State Biotech Coordination Committee (SBCC), and District Level Coordination Committee (DLCC; MOST, DBT, 2011).

While the RDAC is advisory only, IBSC, RCGM, and GEAC are involved in regulatory enforcement. Both SBCC and DLC are responsible for monitoring the activities related to GMOs at a state level. RDAC, RCGM and GEAC are constituted at a national level governed by DBT and MOEF. The IBSCs work on the areas of GMOs, while SBCC works for states and DLCCs works for districts wherever necessary.

Governance Framework

India is taking a so-called "democratic" approach for its biotech management, which is somewhat different from China and other countries. In the Indian biotech governance system, we see three-level interest groups who are interactive and interrelated.

- At the central government level, DBT at MOST, MOEF, and MOA are significant institutions who work on agri-biotech under different approaches;
- Authorized review and appraisal groups, mainly including the important institutions, such as IBSCs, RCGM, and GEAC (the first two institution members are appointed by DBT, while GEAC members are appointed by MOEF).
- State- and district-level interactions, mainly including SBCC and DLCC.

While DBT at MOST is generally the coordinator of agri-biotech operations in India, other important ministries, MOEF and MOA, play a significant role in managing agri-biotech. In addition, the Ministry of Health and Family Welfare (MHFW) is also actively involved in many cases. While these four institutions involved with agri-biotech development bring different perspectives, they also interact with one another. For example, when DBT reviews agri-biotech development in terms of an application from the S&T perspective, MOEF looks into it in terms of an environmental concern. This interaction can be coordinated in many situations. However, in certain cases, their group interest is inconsistent and even in conflict.

As mentioned, IBSCs, RCCM, and GEAC relatively independently review and appraise agri-biotech related research, applications, and commercialization. While both IBSC and RCCM are affiliated with or appointed by DBT, GEAC reports to MOEF. These institutions have different roles in looking into the agri-biotech practices in India. IBSCs review the experiments from Category I and II.[15] RCGM reviews Category III GM products and field experiments and recommends the reviewed GM products to relevant institutions, such as GEAC. GEAC is a relatively important institution for GM products. Its major function involves assessing large-scale agri-biotech applications and making recommendations to the ministerial-level authorities.

Indian agri-biotech is not only managed at the central government level through designated ministerial agencies and other authorized institutions, it is also bound to the state-level institutions for review and monitoring. At the state and district level, SBCC and DLCC are mainly involved. The former works with the state-level governments on biotech and the latter relates to other shareholders for GM products at a district level. They also investigate the GM products and report to other relevant institutions, such as GEAC. To be specific, SBCC periodically reviews the safety and control measures in various institutions handling GMOs to act as an agency at a state level to assess the damage, if any, due to release of the GMOs and to take on site control measures. DLCC monitors the safety regulations in installations and acts as an agency at a district level to assess the damage, if any, due to release of the GMOs and to take on-site control measures.[17]

Approval Process

The duration of India's agri-biotech approval processes vary from three to five years. Some might even be over 10 years, depending on the different products imported or domestic biotech applied. Throughout the process, an applicant is involved with a number of authorized

institutions for review and assessment (Figure). After these steps, the applicants go for final approvals at the ministerial level before releasing for commercialization. The Bt brinjal application is a typical example of how the Indian agri-biotech review, appraisal, and approval process works.

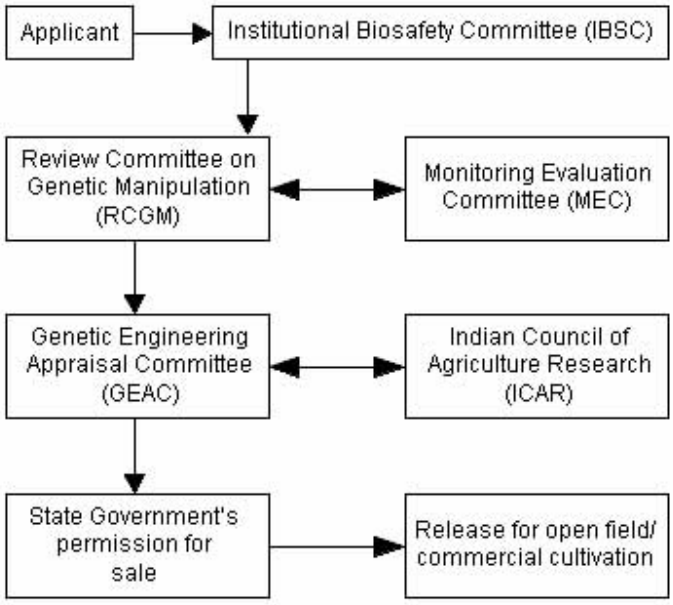


Figure : Agri-biotech approval process in India.

Source: Kumar (2007) and US Department of Agriculture (USDA), Foreign Agricultural Service (FAS; 2011, 2012).

It takes time for an agri-biotech review, appraisal, and approval process due to India's complicated governance system. The applications are at first reviewed by an IBSC. In this stage, applicants need to conduct a number of initial evaluations and field trials. In terms of the Bt brinjal application, Mahyco, an Indian seed company at Maharashtra state, conducted transformation and breeding for integration of Cry1Ac gene into brinjal hybrids in 2000. Following this, a preliminary greenhouse assessment of the development and efficacy of Bt brinjal was done during the period between 2001 and 2002. Then confined field trials were conducted from 2002 to 2004 to study Bt brinjal's pollen flow and growth, germination, and biochemical toxicity.

For those biotech crops with a high level of risk, their applications are further reviewed by RCGM, along with the Monitoring Evaluation Committee (MEC) review of the field trials. In 2004, the data on the effect of Bt brinjal on soil microflora, efficacy against the fruit and shoot borer (FSB), pollen flow, and chemical composition was submitted to RCGM. In the same year, RCGM approved multi-location research trials (MLRTs). By 2007, Mahyco and the Indian Council of Agricultural Research (ICAR) conducted MLRTs separately for this crop. The applicant submitted the biosafety, environmental safety, gene efficacy, and agronomic performance data to GEAC in 2007.

In the third step, GEAC reviews and appraises the applications. This is the last but significant step before an application is submitted to the ministerial-level authority for approval and release. From 2007 to 2009, GEAC approved seven Bt brinjal hybrids for large-scale field trials under the Indian Institute of Vegetable Research in ICAR. In the meantime, GEAC also approved the experimental seed production of seven Bt binjal hybrids. After this process, GEAC, as one of India's authorized biotech regulators, recommended to MOEF in October 2009 for a commercial release of Bt brinjal.

MOEF conducted a number of consultations across India after GEAC's recommendation for Bt brinjal's commercial release. During the consultation, several states and cities, including Kolkata, Bhubaneswar, Ahmedabad, Nagpur, Chandigarh, Hyderabad, and Bangalore, expressed opposition to Bt brinjal (Kutty, 2012). As a result, Jairam Ramesh, the minister in charge of MoEF, declared a moratorium on Bt brinjal in February 2010. Since then, commercial release of Bt brinjal has been suspended. As we know, India is a country with ongoing controversies among the policy makers, academia, and public. The final step for the applicant to request the government's permission for commercial production and sale of Bt brinjal failed. If this step was successful, the applicant would also need to go to SBCC and/or DLCC for review and assessment.

Proposed Biotech Regulatory Authority of India (BRAI)

India's existing agri-biotech governance includes a number of ministries within a complicated system. Meanwhile, the current system lacks a solid legal foundation for support. It relies simply on the Rules 1989, which focused on environmental concerns. According to the document, the purpose for developing BRAI is to promote the safe use of modern biotech by enhancing the effectiveness and efficiency of regulatory procedures. It also intends to regulate the research, transport, import, manufacture, and use of organisms and products of modern biotechnology. Since the draft of this bill was released in 2008, there has been a continuous debate on its necessities and functions. Those opposed view BRAI as unconstitutional due to agriculture being a state subject. BRAI assumes the state government's authority to make decisions, such as those surrounding GM products. It is also argued that BRAI is non-scientific and lacking in public participation due to most of the officials proposed being bureaucrats without involving a civil society representation.

BRAI is a comprehensive proposal to rebuild an Indian biotech governance system. According to this proposal, there would be a three-level governance system. At the top governance body, there would be one chairperson, two full-time members, two part-time members, and two advisory bodies—Inter-Ministerial Governing Board (about 10 delegates) and Biotech Advisory Council (no more than 15 members). The operational level would include one product ruling committee, risk assessment and enforcement units, and three divisions covering agriculture, forestry, and fisheries; human health and veterinary; and industrial and environmental application (Figure 4).

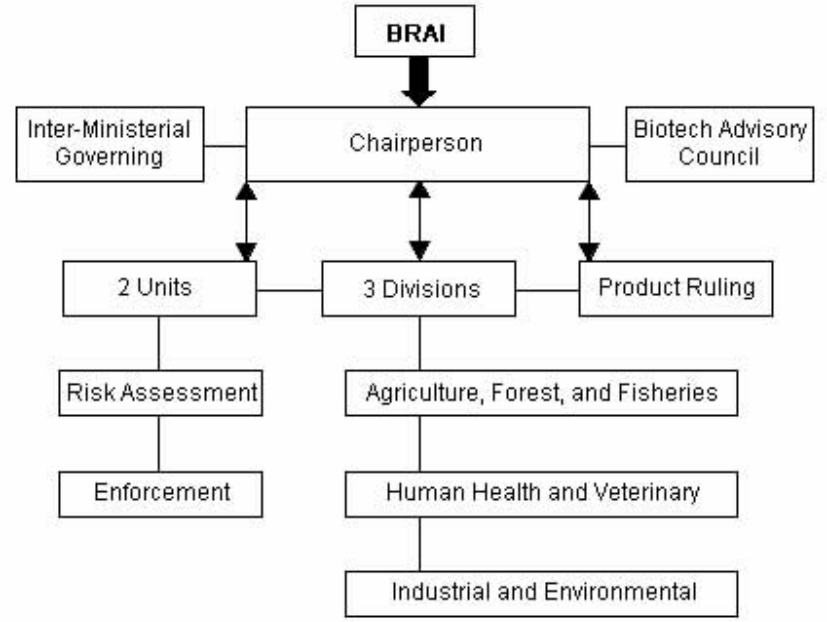


Figure. Proposed biotech regulatory authority of India.

Note: This chart is based on the BRAI bill (2011).

This proposal would make BRAI an independent, autonomous, statutory agency established by the Government of India to safeguard the health and safety of the people of India and to protect the environment by identifying risks posed by, or as a result of, modern biotech, and managing those risks through regulating the safe development and deployment of biotech products and processes. In the interim, in addition to the Rules 1989 governing biotech products, GM foods are also regulated by the Food Safety and Standards Authority under the Food Safety and Standards Act (FSSA) of 2006. Product safety, efficacy, clinical trials, and market authorization of recombinant drugs are regulated by the Drug Controller General of India (DCGI) under the authority of the Drugs and Cosmetics Rules 1945 (well-known as the "Rules 1945") of the Drugs and Cosmetic Act 1940. BRAI would work to consolidate all the regulations into one authorized body for enforcement.

BRAI would also be responsible for GM-food safety assessment. The rules and regulations that pertain to food (e.g., conventional safety provisions related to adulterants, extraneous matter, and unhygienic/unsanitary processing or manufacturing of food) would still apply to GM food as regulated by FSSA and other authorities in India under BRAI. Finally, BRAI would be responsible for regulating GMOs with applications in human and veterinary health and derived products. This would include the regulation of recombinant biologics such as DNA vaccines, recombinant gene therapy products and recombinant- and transgenic-plasma-derived products like clotting factors and veterinary biologics. This excludes therapeutic proteins derived from recombinant organisms, which continue to be regulated by DCGI in India.

Concluding Remarks

India is traditionally an agricultural-based country, with the largest area under cotton production in the world. Bt cotton adoption in India reached 11 million hectares, almost three times the Bt cotton area of China at about 4 million hectares. The number of farmers using Bt cotton increased from 50,000 in 2002-2003 to 7 million in 2011-2012. Despite the unprecedentedly high adoption rate of Bt cotton (95% of area and by more than 7 million farmers), anti-biotech groups still continue to vigorously campaign against biotech in India. These groups use all available means to discredit biotech, such as filing public-interest writ petitions and pursuing litigation in the Supreme Court to contest the biosafety of biotech products (James, 2011, 2012).

In order to establish and empower the biotech regulatory incentives, the Indian policy and regulatory agency (DBT) has been promulgating the legislation to implement the BRAI. Elements of biotech regulation are currently spread over multiple acts and agencies, many of which will need to be amended in order to establish and operate BRAI. The new legislation, when it becomes effective, would provide an opportunity to consolidate and enhance the efficiency and effectiveness of biotech development, increase collaboration with state governments in this area, promote public confidence in the regulatory system, and facilitate international trade.

More: http://www.agbioforum.org/v18n1/v18n1a09-dang.htm

Biotech parks/Incubators

The Biotech Parks and Bitoech Incubation Centres provide an excellent template for the promotion of Biotech start -up companies and the promotion of Public Private Partnership. Biotech Parks are facilities created mainly to promote tiny, small and medium biotech entrepreneurs. The Biotechnology Parks and Biotech Incubation Centres provided a good template for the promotion of Biotech start up companies and the promotion of Public Private Partnerships. Biotechnology has the potential to provide environment friendly products and processes in almost all areas of economy. The biotech industry included either service driven companies, or product driven companies. In India, biotechnology has created lot of employment especially in agriculture and allied sectors.

Tiny and small entrepreneurs can initiate modern biotech products if they come from academia with proof of concepts with them. Such possessions require a backup of basis research with potentials of applications. The Indian Academia is not based upon the application-oriented research; there may not be many who are ready to come forward to take a business risk.

Biotechnology parks are established to facilitate product advancement and innovation through the development of biotechnology industrial cluster and to produce biotechnologists and entrepreneurs who have strong foundation in research and innovation.

With large number of multinational and bio-pharma companies initiating their R&D and manufacturing operations in India, the demand of biotech incubators has increased. Both Central and State Governments are making their earnest efforts to promote biotechnology activities in the country by setting up biotechnology parks, incubators as well as pilot projects through public private partnership. DBT has supported the following biotechnology parks and

incubation centres located in different states for the promotion of Biotech start-up companies and the promotion of Public Private Partnerships.
Biotech Parks are facilities created mainly to promote tiny, small and medium biotech entrepreneurs. The Biotechnology Parks and Biotech Incubation Centres provided a good template for the promotion of Biotech startup companies and the promotion of Public Private Partnerships. Tiny and small entrepreneurs can initiate modern biotech products if they come from academia with proof of concepts with them. Such possessions require a backup of basis research with potentials of applications.

Biotech companies located at biotech parks are eligible for benefits as per the recent changes in the Foreign Trade Policy:

- Duty-free import of equipment, instruments and consumables.
- Tax holiday under Section 10A / 10B of the Income Tax Act

A scheme will be put in place for operationalizing of the incentives to biotech units located in biotech parks. As a part of this scheme biotech company located in biotech parks to be allowed a five-year time frame to meet the export obligation norms under the SEZ scheme. This measure helps to address the long and unpredictable gestational time lines that are inherent to biotech product development. Diverse array of biotech parks creates healthy competition.

1. Bangalore Bio-innovation Centre

Bangalore Bioinnovation Centre (BBC) is envisioned to be a state of the art incubation centre catering to the needs of start ups in the broad areas of Life Sciences

- The Bangalore Bioinnovation Centre (BBC) is an initiative of Karnataka Biotechnology and Information Technology Services (KBITS), Dept of IT, BT and S&T, Government of Karnataka with a liberal funding support from Department of Biotechnology (DBT), Government of India. It is located within Bangalore Helix Biotechnology Park at Electronic City. The Centre is a world class Incubation Centre with Central Instrumentation Facility in a 10 Acre campus with total built up area of above 50,000 sq ft.
- The Centre is nestled between thriving Academic Institutions like Institute of Biotechnology and Applied Biotechnology (IBAB), Centre for Human Genetics and the upcoming area for anchoring Big Companies/MNC's. Thus, the Centre provides a crucial link within the developing Bio- cluster, the Bangalore Helix Biotech Park.
- The Centre caters to the broad areas of Life Sciences i.e, Healthcare (MedTech/ Pharma/Bio-Pharma), Agriculture, Food/ Nutrition, Industrial Biotechnology and Environmental Biotechnology.

Bangalore Bioinnovation Centre
Bangalore Helix Biotech Park
Electronics City Phase 1
Bangalore – 560 100
E mail: info@bioinnovationcentre.com
Ph: +91 9483717532
More: http://www.bioinnovationcentre.com/

2. Biotech Park at Lucknow

The Biotechnology Park, Lucknow located in the City of Nawabs – now transformed to a Biotechnology City, decorates Lucknow with a futuristic state of the art facility for biotechnology led enterprises. It is the only functional Biotechnology Park in the North India serving the State of Uttar Pradesh to bring biotechnology as the the way of cultivating crops, living a healthy life and enriching the skills for boosting biotech industry. The Park was set up jointly by the Department of Biotechnology, Government of India & Department of Science and Technology, Government of Uttar Pradesh in the year 2002 and became fully functional in the year 2007.

Biotech Park, Lucknow is registered under the Indian society Act 21 (1868). The Park is ably-run under the guidance of the society, Governing Board, Advisory-cum-Managing committee and other duly constituted committees.

Sector G, Jankipuram,
Kursi Road, Lucknow - 226021

Uttar Pradesh - INDIA
Tel.+91 522 4012091, 2365050
More: http://www.biotechpark.org.in/

3. Biotech Parks in Rajasthan

RIICO has developed Bio Tech Park in an area of about 30 acres at sitapura, Jaipur. The park is located on Jaipur KotaNtional Highway, just 4 km from the Airport and about 15 km from the city. Good quality infrastructure such as earth station power, telecom, roads, educational institutions, water supply etc Biotech Park at Boranada,Jodhpur: RIICO has developed another BioTec park in an area of about 30 acres at Boranada near Jodhpur. The parks is located about 15 km from the city. Good quality infrastructure is available in the park. Biotech Park at Chopanki: RIIcO has developed Bio Tech Park in an area of about 45 acres and is located about 15 km from Bhiwadi . Good quality infrastructure such as power, road, water , supply etc is available in the park.

Address: RIICO, Udyog Bhawan, Tilak Marg
Jaipur, Rajasthan, India.
More: http://www.poulvet.com/directory/profile.php?addrid=12035

4. Golden Jubilee Biotech Park for Women Society, Kanchipuram

The Park was set up with financial support, in form of grant, from Department of Biotechnology (DBT), Govt. of India, New Delhi and technical support from M S Swaminathan Research Foundation in the 20 acres land allotted by the Government of Tamilnadu & implemented by Tamilnadu Industrial Development Corporation (TIDCO). The Park began its commercial operations in 2001 and over the years has proved to be a successful and unique venture in women entrepreneur development in the Biotech Sector. The Park has been designed based on the principle of decentralized production supported by centralized services to promote a series of biotechnology based enterprises in the areas of Agro, Food & Nutrition, Medical & Healthcare with a huge focus on mentoring, training, capacity building and providing escort services.

Address: Golden Jubille Biotech Park for Women Society,

Siruseri Village,
Inside SIPCOT- IT Park,
4th Main Road, 2nd Cross Road,

Old Mahabalipuram Road, Navalur Post
Kanchipuram District-603103
More: http://www.biotechpark.co.in/index

5. Biotech Park - Savli, Vadodara

The Government of Gujarat through its nodal agency Gujarat State Biotechnology Mission (GSBTM) & Gujarat Industrial Development Corporation (GIDC) are setting up a Biotechnology Park at Savli Industrial Estate at Vadodara. The proposed Park would be developed as a Public-Private Venture in an area of about 700 acres in three phases. The proposed Park would endeavour to address the biotech industry's need for specialized infrastructure and thereby encourage new biotech enterprises, drive life sciences research, accelerate commercialization of new technologies, enable biotech organisations to forge alliances and enhance competitiveness of biotech companies located in the State.

Gujarat State Biotechnology Mission
Department of Science & Technology,
Government of Gujarat
Udyog Bhavan, 11th Block,
9th Floor, Sector - 11,
Gandhinagar - 382 017
Gujarat – INDIA
More: https://btm.gujarat.gov.in/bt-park-savli.htm

6. **Guwahati Biotech Park, Guwahati, Aasam**

Guwahati Biotech Park (GBP), where Science and business form a platform to promote entrepreneurship in the Northeast India. Situated in northern bank of the river Brahmaputra, surrounded by lush green environment and in proximity to premier Institutes of Northeast India: IIT Guwahati, Assam Engineering College, Institute of Advanced studies of Science & Technology and Gauhati University and the Brahmaputra Industrial Park.

GBP is a visionary project launched by an autonomous society under the Government of Assam. The founders of the GBP hope to change the economic condition of the region and the state, thereby increasing the opportunities for the citizens of North Eastern and Eastern India. GBP aims to be a place where educators, researchers and business class come together as collaborative partners for the upliftment of science and technology entrepreneurship in Northeast India.

Technology Complex
IIT Guwahati
Guwahati-781039
Tel: 0361-2690228
Fax: 0361-2690227
More: http://guwahatibiotechpark.com/

7. International Biotech Park, Pune

International Biotech Park is located in Pune, a city known for it's talented Human resource, pleasant climatic conditions and the Presence of Research institutes like, NCL, NIV, IISER, Agarkar research Institute, University of Pune, NCCS, STPI, Vasantdada Sugar research institute, and NARI etc. make Pune a complementary destination for Science based industries.

Pune is also home to majority of Life Science Industries like Emcure, Serum Institute, Hindustan Antibiotics, Lupin, Praj, SciGen etc.

Proximity to Mumbai, availability of talented Human Resource, developed infrastructure, presence of research institutes provides a complete ecosystem for development of knowledge based industries.

Address: Genesis Square, Ground Floor
MIDC Hinjawadi, Phase – II ,
Pune – 411057
Maharashtra, India
More: http://www.ibpl.net/html/location.htm

8. Kinfra Biotech Parks, Kerala

KINFRA Parks are welcome hubs in Kerala for entrepreneurs. KINFRA is credited for powering industrial growth across Kerala through it's industrial parks and industry specific infrastructure. By enabling growth and by cultivating a social and business linkage, KINFRA Parks also acts as role model for social ventures by creating communities who are uplifted by getting better and steady income. At KINFRA, it is an art to develop the infra for the industries to become leaders in their respective areas by assuring quality standards and conducive environment to succeed in their ventures.

Address: KINFRA HOUSE, TC 31/2312,
Sasthamangalam,
Thiruvananthapuram -695 010
More: http://kinfra.org/departments/kinfra-hitec-park-kalamassery-2

9. TICEL Bio Park, Chennai

TICEL Bio Park was established in Chennai, in November, 2004. TICEL acts as a hub for biotech R&D industry in major domains of biotechnology such as medical biotechnology, nutraceuticals, agricultural biotechnology and bioinformatics. The tenancy area has 74 modules of 1,525 sq. ft each, available for clients to develop their own customized R&D labs. Ticel Bio Park, which is also located in Tamil Nadu, has 12 companies in medical biotechnology, nutraceuticals, agricultural biotechnology and bioinformatics. The Bio Park provides the following facilities:

- Bio Resource Centre (Under Consideration)
- Tenancy Area
- Training Centre
- The Bio Park has Proposed to undertake
- Testing, analytical and mentoring services at the
- Bio Resource Centre

Training

Address: Taramani Road
Taramani
Chennai - 600 113, INDIA
More: http://www.ticelbiopark.com/index.html

10. Savli Biotech Park in Vadodara, Gujarat

The State Government of Gujarat, in its resolve and continued endeavors for socio-economic upliftment of society, has identified Biotechnology as most potential tool for development. The State intends to promote biotechnology sector by building appropriate image, encouraging entrepreneurship, strengthening organizational colorations and forecasting business partnerships.

For facilitating the development of biotechnology in the State, Government of Gujarat has constituted Gujarat State Biotechnology Mission, under the aegis of Department of Science and Technology. Gujarat State Biotechnology Mission is a nodal agency of Department of Science & Technology, Govt. of Gujarat to promote, support and facilitate the development of biotechnology in the state by promoting research and development, by generating the quality human resource and by supporting the development of biotechnology industries by taking effective measures and policy and planning level. To promote, support and facilitate the overall development of Biotechnology in the State. To provide institutional, legal, financial and policy support. To facilitate Entrepreneurship in the state, GSBTM is setting up 'Savli Bio-Incubator' – a Technology Business Incubator at Savli Biotech Park, Vadodara.For the development of Savli Bio-Incubator, GSBTM is looking manpower for different positions.
11 companies across all major sectors of biotechnology have been recommended for land allotment in the first phase of the project. The phase I work covers 90 acres, phase II covers 125 acres, and phase III will span up to 500 acres

Address: Gujarat State Biotechnology Mission,
EPIP/CFC Building, GIDC – SAVLI,
Manjusar, Vadodara - 391 775
Gujarat, India
More: http://www.savlibioincubator.in/

National biotech institutes

COUNCIL OF SCIENTIFIC & INDUSTRIAL RESEARCH (CSIR) INSTITUTES

Council of Scientific and Industrial Research (CSIR), established in 1942, is an autonomous body and the largest research and development (R&D) organisation in India. It runs 37 laboratories and 39 field stations or extension centers spread across the nation. Although it is mainly funded by the Ministry of Science and Technology, it operates as an autonomous body registered under the Registration of Societies Act of 1860.
The research and development activities of CSIR include aerospace engineering, Structural engineering, ocean sciences, Life sciences, metallurgy, chemicals, mining, food, petroleum, leather, and environment.

1. Indian Institute of Toxicology Research, Lucknow

Indian Institute of Toxicology Research (formerly, Industrial Toxicology Research Centre), Lucknow, a constituent laboratory of Council of Scientific & Industrial Research, was established in 1965. This multidisciplinary research institute with the motto Safety to Environment and Health and Service to Industry addresses problems critical to human health and environment. CSIR-IITR has GLP Compliance Certification from NGCMA, Government of India, issued with respect to toxicity & mutagenicity studies and NABL accredited facilities for biological and chemical testing.

Vision

From laboratory to field for societal benefit by contributing in niche areas of toxicology.

Mission

IITR, a leader in toxicology research, endeavours to mitigate problems of human health and environment. The institute aims to accomplish its goals through the following objectives:

- Safety evaluation of chemicals used in industry, agriculture and everyday life.
- Mode of action of toxic chemicals/pollutants.
- Remedial/preventive measures to safeguard health and environment from pollutants.
- Occupational health hazards due to exposure in chemicals industries, mines, agricultural fields and environment.
- Simple/rapid diagnostic tests for disorders caused by industrial and environmental chemicals
- Collect, store and disseminate information on toxic chemicals.
- Human resource development for dealing with industrial and environmental problems.
- Provide a platform to public and entrepreneurs to address queries and concerns regarding safety/toxicity of chemicals, additives and products.

Research area

To consolidate the research and development activities of the institute and to focus on niche areas, Research Council has approved the following five groups:

- Nanotherapeutics & Nanomaterial Toxicology
- Environmental Toxicology
- Food, Drug & Chemical Toxicology
- Regulatory Toxicology
- Systems Toxicology & Health Risk Assessment

More: http://www.iitrindia.org

2. The National Environmental Engineering Research Institute (NEERI)

The National Environmental Engineering Research Institute (NEERI), Nagpur was established in 1958 as Central Public Health Engineering Research Institute (CPHERI), when environmental concerns were limited to human health with a focus on water supply/sewage disposal/ communicable diseases and to some extent on industrial pollution and occupational diseases. The chemical and biological solutions to address these problems were simple, though challenging. However, slowly worldwide public awareness on the contamination of environment on regional to global scale started getting attention in 1970's. Shrimati Indira Gandhi, the Prime Minister of India, rechristened the Institute as National Environmental Engineering Research Institute (NEERI) in the year 1974.

National Environmental Engineering Research Institute (NEERI), Nagpur is devoted to research and innovations in environmental science and engineering besides solving a range of problems posed by industry, government and public. NEERI dedicates itself in the service of mankind by providing innovative and effective solutions to environmental and natural resource problems.

Vision
Leadership in environmental science and engineering for sustainable development.

Mission
NEERI would continue to strive for providing innovative and effective solutions for environmentally sustainable development and to help government, industry and society, especially the 800 million underprivileged people of India.

Achievements
National Environmental Engineering Research Institute (NEERI), Nagpur is a constituent of Council of Scientific & Industrial Research (CSIR), New Delhi and has a nation-wide presence with its five zonal laboratories at Chennai, Delhi, Hyderabad, Kolkata and Mumbai. The mandate of NEERI is:

- To conduct research and developmental studies in environmental science and engineering
- To render assistance to the industries of the region, local bodies, etc. in solving the problems of environmental pollution through S&T intervention
- To interact and collaborate with academic and research institutions on environmental science and engineering for mutual benefit
- To participate in CSIR thrust area and National mission projects

More: http://www.neeri.res.in/

3. The Institute of Minerals and Materials Technology (IMMT) Bhubaneswar, Odisha

The Institute of Minerals and Materials Technology-IMMT, (formerly Regional Research Laboratory, Bhubaneswar) was setup as a premier establishment of the Council of Scientific & Industrial Research (CSIR), New Delhi in 1964 in the State of Odisha, in eastern India. The laboratory specializes in providing R&D support for process and product development with special emphasis on conservation and sustainable utilization of natural resources. Over the years, IMMT has developed S&T capabilities in a wide range of areas from mineralogy to materials engineering. The laboratory has expertise in conducting technology oriented programmes in mining and mineral/bio-mineral processing, metal extraction and materials characterization, process engineering, industrial waste management, pollution monitoring and control, marine and forest products development, utilization of medicinal and aromatic plants and appropriate technologies for societal development.

Research Area

- Plasma processing of minerals, wastes and special materials.
- Metals & alloy making
- Production of carbide, oxide and nitride powders including ultrafine and nano powders.
- Preparation of electronic and high pure materials.
- Microstructural and physical properties studies of defects reduced natural gems.
- Advanced characterisations of special and advanced materials.
-

Research

Advanced Materials Technology
Central Characterization Cell
Colloids & Material Chemistry
Design & Project Engineering
Environment & Sustainability
Hydro & Electrometallurgy
Mineral Processing
Process Modeling & Instrumentation

Achievements

- Jet-wheel impact atomization based spray dryer for spheroidization of alumina grain to improve powder flowability (26 kW) -funded by BRNS, Mumbai
- Setting up of a pilot plant demonstration unit (30 kg/h Capacity) for production of synthetic rutile, pig iron and high purity iron oxide from ilmenite Concentrate using thermal plasma - funded NMDC, Hyderabad.
- Preparation of synthetic rutile by plasma smelting of ilmenite followed by acid leaching - funded by BRNS, Mumbai
- TiO_2 rich slag from pre-reduced ilmenite – funded by Kerala State Committee on Science & Technology, Govt. of Kerala
- Environmentally secured rare earth based colourants NMITLI project CSIR,New Delhi
- Thermal plasma synthesis of SiC, WC and TiC – funded by DST, New Delhi
- Experimental investigations on smelting reduction process – funded by RDCIS, Ranchi
- Development of thermal plasma processes for preparation of monoclinic and stabilized zirconia – funded by BRNS, Mumbai
- Preparation of iron carbide and SG iron – funded by RDCIS, Ranchi
- Smelting of ferromanganese by plasma technology – funded by RDCIS, Ranchi
- Preparation of zircon based ceramic pigment – funded by IRE, Chattrapur
- Microalloyed cryo steel development for Nb_3Sn superconductor cable conduct jacket of tokomak magnet- funded by BRFST, Gandhinagar.

More: http://www.immt.res.in/

4. Institute of Microbial Technology (IMTECH), Chandigarh

Established in 1984, the Institute of Microbial Technology (IMTECH) is one among the chain of 37 national laboratories, 6 units and 39 outreach centres of the Council of Scientific & Industrial Research. Set-up to be a fore-runner in the niche domain of microbial biotechnology, the Institute in its initial years functioned from a start-up laboratory that provided a truly world-class R&D ambience in an area of over 10,000 sq. ft. to its researchers.

Mandate of IMTECH

- To provide integrated research, development and design base for microbial technology.
- To undertake basic and applied research and development programmes in established and newly emerging areas of relevant biotechnology including genetic engineering.
- To optimise the existing microbial processes currently available and in use in the country.
- To develop and maintain gene pool resources and genetic stocks of microbial cultures and other cell lines. This could also serve as a reference centre to assist other centers.
- To establish facilities for biochemical engineering, instrumentation development including microprocessor systems, a computer centre and development of mathematical models for process parameters.
- To establish facilities for design of process equipment and bioreactors.
- To impart training in microbiology, microbial technology and biochemical engineering.
- To conduct training and refresher courses for research workers and technologists.
- To establish documentation and information retrieval and dissemination facilities and a data bank to meet the needs of the Institute.
- To establish and maintain effective linkages with industry and educational institutions.
- To develop capabilities for producing design and engineering packages for industrial plants.

Research Areas

Exploration of Microbial Biodiversity
Protein Science and Engineering
Genetics and Molecular Biology
Cell Biology and Immunology
Biochemical Engineering: Fermentation based Process Development
Bioinformatics
Biosensors and Nanotechnology
Bio-Organic Chemistry

More: http://www.imtech.res.in/

5. Institute of Genomics & Integrative Biology (IGIB), Delhi

5. Institute of Genomics and Integrative Biology (IGIB), Mall Road, Near Jubilee Hall, Delhi

Institute of Genomics & Integrative Biology (IGIB), Mall Road, Near Jublee Hall, Delhi is a premier Institute of Council of Scientific and Industrial Research (CSIR), engaged in research of national importance in the areas of genomics, molecular medicine, bioinformatics, proteomics and environmental biotechnology. It was established in 1977 as the Center for Biochemical Technology (CBT). The Functional Genomics Unit was established in 1998 with the focus shifting from chemical to genomics research. The institute was rechristened "Institute of Genomics and Integrative Biology" in 2002 and encompassed Computational and Bioinformatics approaches in making a deliberate shift towards Integrative Biological Research.

Mission

"To translate concepts developed in basic biological research to commercially viable technologies for health care".

Research area

I. Genomics and Molecular Medicine
II. Respiratory Disease Biology
III. Genome Informatics and Structural Biology
IV. Energy and Environmental Biotechnology
IV. Chemical & Systems Biology
V. Ayurgenomics

Source: http://www.igib.res.in/

6. The Centre for Cellular and Molecular Biology (CCMB), Hyderabad

The Centre for Cellular and Molecular Biology or CCMB is an Indian Biotechnology research established in 1977 of the Council of Scientific and Industrial Research located in Hyderabad, India. The objectives of the Centre are to conduct high quality basic research and training in frontier areas of modern biology, and promote centralized national facilities for new and modern techniques in the inter-disciplinary areas of biology.

Objectives

- ✓ To conduct research in frontier and multi-disciplinary areas of modern biology and to seek potential applications of this work.
- ✓ To train people in the advanced areas of biology to serve the needs of development in these areas, with special provision for short-term training of staff from other institutions in techniques for which adequate facilities may not exist elsewhere.
- ✓ To provide centralized facilities in the country for new and modern techniques in the inter-disciplinary areas of biology, and to ensure that these facilities are so organized, maintained and administered that they can be put to maximal use by research workers from other laboratories and institutions in the country.

Research area

- Biomedicine and Biotechnology
- Genetics & Evolution, Genomics
- Cell Biology & Development
- Molecular Biology and Structural Biology
- Biochemistry & Biophysics
- Infectious Diseases
- Computational Biology & Bioinformatics

More: http://www.ccmb.res.in/

7. National Institute of Oceanography (NIO), Goa

National Institute of Oceanography (NIO) was established on 1 January 1966 following the International Indian Ocean Expedition (IIOE) in the 1960s. The institute has since grown into a multi-disciplinary oceanographic research institute of international repute. The principal focus of research has been on observing and understanding special oceanographic characteristics of the Indian Ocean. Its headquarters at Dona Paula, Goa, and regional centres at Kochi, Mumbai and Visakhapatnam, is one of the 37 constituent laboratories of the Council of Scientific & Industrial Research (CSIR), New Delhi.

Research area

The major research areas include the four traditional branches of oceanography - biological, chemical, geological/geophysical, and physical – as well as ocean engineering, marine instrumentation and marine archaeology.

In addition to basic research, the institute also carries out applied research sponsored by the industry. These studies include oceanographic data collection, environmental impact assessment, and modelling to predict environmental impact.

Motto

"To continuously improve our understanding of the seas around us and to translate this knowledge to benefit all"

More: http://www.nio.org/

8. National Chemical Laboratory (NCL), Pune

National Chemical Laboratory (CSIR-NCL), Pune, established in 1950, is a constituent laboratory of Council of Scientific and Industrial Research (CSIR). CSIR-NCL is a science and knowledge based research, development and consulting organization. It is internationally known for its excellence in scientific research in chemistry and chemical engineering as well as for its outstanding track record of industrial research involving partnerships with industry from concept to commercialization.

Vision

- To be a globally recognized and respected R&D organization in the area of chemical sciences and engineering.
- To become an organization that will contribute significantly towards assisting the Indian chemical and related industries in transforming themselves into globally competitive organizations.
- To become an organization that will generate opportunities for wealth creation for the nation and, thereby, enhance the quality of life for its people.

Mission:

✓ To carry out R&D in chemical and related sciences with a view to eventually deliver a product, process, intellectual property, tacit knowledge or service that can create wealth and provide other benefits to NCL's stakeholders.
✓ To build and maintain a balance portfolio of scientific activities as well as R&D programs to enable NCL to fulfill the demands of its stakeholders, present and future.
✓ To create and sustain specialized Knowledge Competencies and Resource Centers within NCL which can provide support to all stakeholders of NCL.
✓ To contribute to the creation of high quality Ph.D. students with competencies in the area of chemical, material, biological and engineering sciences.
✓ Analytical Chemistry & Materials Characterization

Research themes

- Chemical Engineering
- Industrial catalysis and catalytic processes
- Industrial catalysis research at NCL is aimed at the development of innovative catalysts consisting ...
- Mathematical & Computational Modelling
- Bio-chemical and biological sciences
- Energy & Environmental Engineering
- Material Science and Engineering
- Organic Synthesis and Technology

More: http://www.ncl-india.org/

9. Central Drug Research Institute (CDRI), Lucknow

Central Drug Research Institute is one of the first and few laboratories that were established in India right after its independence. CDRI is among the thirty eight laboratories that are functioning under the aegis of the council of scientific and Industrial Research (CSIR) of India headed by the Prime Minister of the nation as its president. CDRI was formally inaugurated on 17th Feb 1951 by the then

Prime Minister of India, Pandit Jawahar Lal Nehru.

CDRI is considered to be a pioneer research organization in the field of biomedical research where all the infrastructure and expertise are available to develop a drug right from its concept to market. The very latest techniques and methodologies are employed for developing drugs, diagnostics and vaccines to combat diseases prevalent among mankind in general and Indian population in particular.

CDRI is a multidisciplinary research laboratory consisting of scientific personnel of various areas of biomedical sciences. For administrative and scientific purposes the Institute's manpower has been grouped into 17 R & D divisions and few divisions providing technical and scientific support. In order to carry out work in cohesion and in a focused environment, the research works have been grouped into following six major research areas.

Research Areas

Research activities of CDRI are aimed at developing drugs, diagnostics and vaccines to cure and get rid of the ailments confronted by the mankind in general and indians in particular. With an aim to carry out focussed works in various disease areas, the R & D activities of CDRI have been categorised in various research areas. Each Research Area focusses on the design and development of drugs, diagnostics/vaccines related to the concerned disease group right from the synthesis of compounds upto regulatory studies and clinical trials. Scientists and technical manpower attached to a particular project area work in cohesion as per the guidelines adopted by each project coordination group, even though they are administratively attched to their individual divisions

Quarterly project meetings of each area take stock of the progress in the area and wherever necessary, fresh guidelines are issued to overcome any hurdle that may have been faced.
Research activities are broadly divided into three subgroups.

- Drug Discovery & Development
- Regulatory Studies
- Infrastructural Support Groups

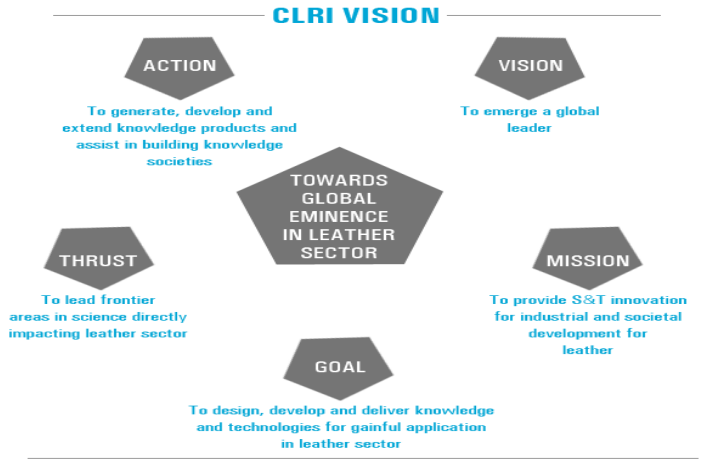
More: http://www.cdriindia.org/home.asp

10. Central Leather Research Institute (CLRI), Chennai

Central Leather Research Institute was founded on 24 April, 1948. CLRI made an initiative with foresight to link technology system with both academy and industry. State-of-art facilities in CLRI support, innovation in leather processing, creative designing of leather products viz. leather garment, leather goods, footwear and

development of novel environmental technologies for leather sector.

Vision & Mission



Mandate

- To seek excellence in research in Frontier areas
- To serve the national apex body in leather
- To Participate in HRD through direct role in education and training in leather related areas
- To assess and forecast technology needs
- To serve as a reliable consultant to leather sector
- To develop technologies and deliver to the industry through effective extension network
- To serve as a dependable source of technologies and
- To provide a technology supermarket for users

More: http://www.clri.org/

11. Central Food Technological Research Institute(CFTRI), Mysore

Central Food Technological Research Institute(CFTRI), Mysore (A constituent laboratory of Council of Scientific and Industrial research, New Delhi) came into existence during 1950 with the great vision of its founders, and a network of inspiring as well as dedicated scientists who had a fascination to pursue in-depth research and development in the areas of food science and technology.

MISSION

- Generate and apply knowledge of food science and food technology for optimal conservation and utilisation of the nation's food resources
- Integrate scientific and technological knowledge into conventional and traditional systems and practices, and local and regional realities
- Add value and utility to agro-resources through R&D and contribute to sustained development, food security and food safety
- Aid and promote the development of food industry through inter-disciplinary, innovative and state-of-the-art solutions
- Set national standards for food quality, and spread food quality consciousness all around
- Sustain leadership in long-term strategic research and technology development
- Integrate the food supply chain from the cultivator to the consumer so that cultivators get optimal returns from processing, and consumers get the food that they want, when they want, where they want, in whatever form they want and at affordable cost
- Build and bolster bonds with nodal agencies from the global to the grassroots level, particularly in the area of multi-level human resources development
- Develop new knowledge continuously, to address contemporary challenges and answer future emergencies

More: http://www.cftri.com/

12. Central Institute of Medicinal and Aromatic Plants (CIMAP), Lucknow

Central Institute of Medicinal and Aromatic Plants, popularly known as CIMAP, is a frontier plant research laboratory of Council of Scientific and Industrial Research (CSIR). Established originally as Central Indian Medicinal Plants Organisation (CIMPO) in 1959, CIMAP is steering multidisciplinary high quality research in biological and chemical sciences and extending technologies and services to the farmers and entrepreneurs of medicinal and aromatic plants (MAPs) with its research headquarter at Lucknow.

Research area

Agronomy
Soil Science

Biotechnology
Plant Biotechnology
Molecular Bioprospection

Chemical science
Analytical Chemistry
Medicinal Chemistry
Process Chemistry & Technology

Crop protection
Microbial Technology & Nematology
Plant Pathology

Genetics and plant breeding
Genetic Resource Management
Plant Breeding

Plant biology
Botany & Pharmacognosy
Molecular & Structural Biology
More: http://www.cimap.res.in/english/index.php

13. Central Institute of Mining and Fuel Research (CIMFR), Dhanbad

The Central Institute of Mining and Fuel Research (CIMFR) Dhanbad, is a constituent laboratory of Council of Scientific & Industrial Research (CSIR) was aimed to provide R&D inputs for the entire coal-energy chain from mining to Consumption through integration of the Core Competencies of the two (CFRI & CMRI) premier Coal institution of the country. The newly formed entity CIMFR Dhanbad, a constituent laboratory of Council of Scientific and Industrial Research (CSIR) would be the premier organization of the country providing basic research, R & D back up, advisory services and help in technology up-gradation & adaptation to coal and mineral based industries to reach the targeted production with high standards of safety, economy and cleaner environment. As such CIMFR, Dhanbad would have to have its own vision for discharging its national role effectively to help coal, mineral and other associated industries to get their vision translated into reality.

Mission

- ✓ To plan, perform and deliver reliable, high quality and internationally competitive research and development on coal and minerals for utilization in mining, energy and allied industries in India and beyond.

- ✓ To help the mining industry in general and coal industry in particular with needed knowhow and R&D services covering the entire chain from "Mine to Market".
- ✓ To accord high priority to clean coal initiatives with focus on resource conservation, coal quality up-gradation and coal processing technology packages for power, steel, chemical feedstock and liquid fuels.
- ✓ To generate and help generate high performance human resource (Scientists, Engineers, Technicians) needed in the country.
- ✓ To offer high quality science and technology advice to government at the centre and in the states to facilitate management of technological changes in the areas of mining and fuels.
- ✓ To take at least 25 international patents every five years beginning with XIth Five Year Plan.

More: http://www.cmriindia.nic.in/

14. Central Salt & Marine Chemicals Research Institute, Bhavanagar

With a coastline of about 3,500 miles, inland sources in Rajasthan and Little Rann of Kutch, and the rock salt mines in Mandi, India have possibilities of attaining a high position in salt production among the salt producing countries of the world. As is known, apart from being an indispensable item of food, salt is an important raw material for the manufacture of several heavy chemicals e.g. soda ash, caustic soda and chlorine. Besides, salt is used in food processing industries, such as fish curing, meat packing, dairy products and fruit and vegetable canning.

Mission

The mission of the Institute and its people is to work in partnership with visionary sponsors and collaborators to generate the knowledge and innovations required for efficient utilization of our coastal wasteland, sea water, marine algae, solar power and silicates. The Institute will also harness its capabilities in biosciences, chemical transformation, process engineering, environmental monitoring, separation science and analysis to address focused needs of industries and organizations in the region and beyond.

Current research and development

- ✓ Salt and Marine Chemicals

The activities are centered around the improvement in quality and yield of salt recovered from marine, sub-soil and inland brines and development of processes for the recovery of valuable marine chemicals like potash and magnesium chemicals by the downstream processing of bittern.

- ✓ Inorganic Materials and Catalysis

Was introduced in 1982 with an endeavor of potentially using coordination metal complexes as homogeneous catalysts for environmentally and industrially important reactions utilizing gaseous molecules such as O_2, N_2 and CO. During 1982 to 1991, It has contributed significant research output on the synthesis of metal complexes for reactions such as oxidation, epoxidation, hydroformylation at molecular level.

- ✓ Electro Membrane Processes

Development of Domestic ED unit.
Development of electro - deionization system
Designing and development of Nano composite membranes
Heterogeneous–homogeneous composite bipolar membrane
Electrochemical/chemical value addition processes

Marine Biotechnology and Ecology

- ✓ Molecular Biology and Biotechnology
- ✓ Natural Product Chemistry
- ✓ Seaweed Biology and Cultivation
- ✓ Marine Environment.
- ✓

Reverse Osmosis Engineering

Wasteland Research

Analytical Sciences

Current Research Areas and Interests

- Molecular sensors for selective recognition of cations/anions
- Recognition of analytes and neutral molecules in physiological condition
- Supramolecular metal complexes to study photo-induced energy/electron transfer processes
- Nanocrystalline dye-sensitized solar cells (DSSC)
- Smart Materials
- Green Chemistry
- Recovery of precious metal ions from natural sources
- Crystal engineering
- Computational Study

More: http://www.csmcri.org/index.php

15. Institute of Himalayan Biosphere Technology, Palampur

Govt. of Himachal Pradesh took up initiative in early seventies to set up a CSIR lab to make

prudential use of the natural resources of the region. After several levels of discussions a formal request was made by then Chief Minister of HP to Vice President, CSIR in 1982 for initiating the matter, and giving final shape to the proposal. The dream of HP government finally came true in 1983 when the foundation stone of this National lab was laid as CSIR Complex Palampur by Prof. Nurul Hasan, former Vice President of CSIR, with then Chief Minister of HP chairing the function.

Mission

Providing R&D Services on Economic Bioresources in Western Himalayan Region Leading to Value Added Plants, Products and Processes for Industrial, Societal and Environmental Benefits.

Research area

IHBT is constantly striving to generate new knowledge to fulfill its mission of sustainablemanagement of Bioresources in the himalayan region by adoptinga multidisciplinary approach in R & D activities. The Institute has five Divisions engaged in research of high scientific impact.

National Diagnostics for determination of virus

On February 6, 2004 through a Gazette notification by the Govt. of India, IHBT has been recognized as a centre for testing tissue culture raised plants against viruses in floriculture crops. The facility can be availed by the interested parties to get their micropropagated plants certified.

Pesticide Residue Analysis

IHBT has a Nationally recognized facility to test pesticide residues in tea and herbal products. The lab is equipped with sophisticated instruments and novel protocols are in place to undertake the testing. The facility can be availed to test pesticide level in desired products.

GIS Facility

IHBT has established Geographic Information System and Remote Sensing facility. The lab has hardware like computers, plotter, scanner and software like Erdas Image 8.6, Arc GIS 8.3 etc. The facility can be availed by government organizations and national bodies to know the Landscape element types and assess the land use/ forest covers of the desired area.

Other Facilities

The soil analysis is undertaken on request

Quantitative and Qualitative Estimation of Essential Oils and analyses of Active Ingredients of Medicinal and Aromatic Plants

Analysis of Pesticide Residues and Identification of Pesticide Metabolites

Virus Indexing of Ornamental Plants

The expertise and computation facility can be availed for creation of databases

PRODUCTS AVAILABLE

More: http://www.ihbt.res.in/

16 Indian Institute of Chemical Biology (IICB), Kolkata

The Institute was established in 1935 as the first non official centre in India for biomedical research and was included within the aegis of CSIR in 1956. IICB today is engaged in research on diseases of national importance and biological problems of global interest, employing sophisticated state-of-the-art technology in keeping with the rapid and unprecedented momentum that life science research has gained globally over the last 50 years.

IICB is one of the major institutes in India which initiated, right from its inception, multidisciplinary concerted efforts for conducting basic research on infectious diseases, specifically leishmaniasis and cholera, along with the development of technologies for the diagnosis, immunoprophylaxis, and chemotherapy of the diseases.

Research & Development

- ✓ Cancer Biology & Inflammatory Disorder
- ✓ Cell Biology & Physiology
- ✓ Organic & Medicinal Chemistry
- ✓ Infectious Diseases and Immunology
- ✓ Molecular Genetics
- ✓ Structural Biology & Bioinformatics

More: http://www.iicb.res.in/

17. National Botanical Research Institute (NBRI), Lucknow

The CSIR-National Botanical Research Institute (NBRI) - is amongst one of the constituent research institutes of the Council of Scientific and Industrial Research (CSIR), New Delhi. Originally set up as the National Botanic Gardens (NBG) by the State Government of Uttar Pradesh (U.P.), it was taken over by the CSIR in 1953. Though, initially engaged in research in the classical botanical disciplines, the NBG went on laying an increasing emphasis, in keeping with the national needs and priorities in the field of plant sciences, on its applied and developmental research activities. A time came when it was felt that the name NBG no longer projected the correct nature and extent of its aims and objectives, functions and R & D activities. Consequently, the NBG was renamed as the NBRI, i.e., The National Botanical Research Institute in 1978. This name has since correctly reflected the distinctive character and the R & D activities of this applied botanical institution only of its type in the country.

Mandate

Performing basic and applied researches on various aspects of plant science including conservation, systematic documentation, prospection and genetic improvement with particular emphasis on under exploited, non-traditional and wild plant genetic resources of the country for the sustainable development and human welfare.

Areas of R & D and Infrastructure

The aims and objectives of the Institute are pursued through various projects distributed among the following five broad areas of R & D supported by S&T support services for their respective activities:

1. Botanic Garden and Distant Research Centers
2. Plant Diversity, Systematics and Herbarium
3. Plant Ecology & Environmental Science
4. Genetics and Molecular Biology
5. Plant Microbe Interaction & Pharmacognosy
6. S&T Support Services

More: http://www.nbri.res.in/index.php

Indian Council of Agricultural Research (ICAR)

हर कदम, हर डगर
किसानों का हमसफर
भारतीय कृषि अनुसंधान परिषद

भाकृअनुप
ICAR

Agrisearch with a human touch

The Indian Council of Agricultural Research (ICAR) is an autonomous organisation under the Department of Agricultural Research and Education (DARE), Ministry of Agriculture, Government of India. Formerly known as Imperial Council of Agricultural Research, it was established on 16 July 1929 as a registered society under the Societies Registration Act, 1860 in pursuance of the report of the Royal Commission on Agriculture. The ICAR has its headquarters at New Delhi.

The Council is the apex body for co-coordinating, guiding and managing research and education in agriculture including horticulture, fisheries and animal sciences in the entire country. With 100 ICAR institutes and 71 agricultural universities spread across the country this is one of the largest national agricultural systems in the world.

The ICAR has played a pioneering role in ushering Green Revolution and subsequent developments in agriculture in India through its research and technology development that has enabled the country to increase the production of food grains by 5 times, horticultural crops by 9.5 times, fish by 12.5 times , milk 7.8 times and eggs 39 times since 1951 to 2014, thus making a visible impact on the national food and nutritional security. It has played a major role in promoting excellence in higher education in agriculture. It is engaged in cutting edge areas of science and technology development and its scientists are internationally acknowledged in their fields.

More: http://www.icar.org.in/

1. The National Bureau of Plant Genetic Resources (NBPGR), Karnal

The National Bureau of Plant Genetic Resources (NBPGR) has its headquarters at New Delhi, located at latitude of 280 35’ N, longitude of 70018’ E and an altitude of 226 m above mean sea level. The Bureau draws guidelines from the Crop Science Division of ICAR, Institute Management Committee, Research Advisory Committee, Institute Research Council and Germplasm Advisory Committees.

Mandate
Identification, Evaluation, Characterization, Conservation and Utilization of Livestock and Poultry Genetic Resources.

Objectives
✓ To conduct systematic surveys to characterise, evaluate and catalogue farm livestock and poultry genetic resources and to establish their National Data Base.
✓ To design methodologies for ex situ conservation and in situ management and optimal utilization of farm animal genetic resources.
✓ To undertake studies on genetic characterisation using modern biological techniques such as molecular cytogenetics, Immunology, DNA Fingerprinting, RFLP analysis etc.
✓ To conduct training programmes as related to evaluation, characterisation and utilisation of animal genetic resources.

Research Achievements
Technologies/Methodologies Developed
Characterization of AnGR
Characterization Major Genes
Functional Genomics
Conservation of AnGR

Available Technologies & Products
- 84,200 cryo-preserved semen doses from 228 bulls belonging to twenty nine breeds of seven livestock species (cattle, buffalo, Sheep, Goat, Yak, Mithun and horse) are preserved in National Genebank of NBAGR.
- 50 random samples of 15 breeds of poultry, 25 breds/populations of goat, 6 breeds of cattle and 4 breeds of sheep are preserved in DNA bank of NBAGR.
- Descriptors of 80 breeds (10 buffalo, 26 cattle, 13 goat and 14 sheep, 4 horse and 13 chicken breeds) in Indian Journal of Animal Sciences.
- Guidelines, descriptors and application form for registration of new breeds prepared and are being distributed to potential stakeholders for registration of new populations as breeds.;
- Guidelines and procedure for registration of varieties/strains/lines of chicken
- Information System on Animal Genetic Resources of India: NBAGR has developed an Information System on Animal Genetic Resources of India (AGRI-IS 2.0).. CD Version of AGRI-IS 2.0 has also been developed using MS-Access which is being supplied on demand.

More: www.nbagr.res.in/

2. National Bureau of Fish Genetic Resources (NBFGR), Lucknow

The National Bureau of Fish Genetic Resources (NBFGR) was established in December 1983 at Allahabad under the aegis of Indian Council of Agricultural Research to undertake research related to the conservation of fish germplasm resources of the country. The Bureau's permanent infrastructure was developed at Canal Ring Road, Telibagh, Lucknow, U.P in 1999. The Institute's vision is assessment and conservation of fish genetic resources for intellectual property protection, sustainable utilization and posterity.

Mandate:

- Collection, classification and cataloguing of fish genetic resources of the country..
- Maintenance and preservation of fish genetic material for conservation of endangered fish species.
- Evaluation and valuation of indigenous and exotic fish species.
-

Achievements

- ✓ Developed database on fish diversity of India containing information about 2953 finfish species.
- ✓ Developed database on Freshwater Fishes of Northeast and Western Ghats, and fish diversity checklists for eight states and three ecosystems (Western Ghats, Gulf of Mannar and Vembanad Lake).
- ✓ Developed four online databases- Fish Barcode Information System, Fish Karyome, Fish and Shellfish Microsatellite Database, and Fish Mitogenome Resource.
- ✓ Extensively explored different rivers basins and two important hotspots viz. Western Ghats and Northeastern States for documentation of fish diversity.
- ✓ Discovered forty three new fish species during explorations of ecologically diverse habitats in India during last 10 years, in collaboration with other partner organizations.
- ✓ Developed genomic resources including expressed sequence tags and gene associated markers in Indian catfish, Clarias magur and Tenualosa ilisha.
- ✓ Phylogenetic relationships of fishes belonging to important groups and genera studied through molecular markers.
- ✓ Initiation of whole genome sequencing of two commercially important fish species, Labeo rohita and Clarias magur in collaborative mode.
- ✓ Molecular markers for 35 finfish species identified. Genomic libraries for 6 fish species constructed for microsatellite identification.
- ✓ Produced quality seed of DMCs for supply to state fisheries department and farmers of Uttar Pradesh and adjacent areas.

- ✓ Population genetic structure of 26 finfish and shellfish species studied across the native distribution range in Indian waters which would help in management strategies, stock-specific conservation and river ranching programmes.
- ✓ Complete mitochondrial DNA sequenced in eight fish species.
- ✓ Species-specific DNA profiles of 11 Harmful Algal Blooms species (8 Dinoflagellates and 3 cyanobacteria) from Indian seas developed for their accurate and timely identification..
- ✓ DNA Barcoding of over 600 Indian marine and freshwaterfinfish and shellfish species completed.
- ✓ Species-specific molecular signatures of commercially important finfish and shellfish species generated to resolve taxonomic ambiguity and for accurate documentation of species diversity
- ✓ Captive breeding protocols developed for 15 ornamental fishes in collaboration with other partner organizations including College of Fisheries, Panangad. Also developed breeding protocols for six endangered fish species for conservation and sustainable utilization.
- ✓ Three legal disputes resolved based on the DNA barcoding, viz., forensic identification of pomphret (Pampus chinensis), endangered and wildlife protected whale shark (Rhyncodon typus) and sea cow (Dugong dugong).
- ✓ Developed sperm cryopreservation protocols for 30 fish species, which can provide support to captive breeding technology in the propagation assisted rehabilitation of the target species in its natural habitat.
- ✓ Ranching of endangered yellow catfish, Horabagrus brachysoma and Malabar labeo, Labeo dussumieri in Vembanad Lake and adjacent rivers in collaboration with RARS, Kumarakom, Kerala resulted in increased landings.
- ✓ Developed in vivo and in vitro assay system for evaluation and assessment of genotoxicity of aquatic pollutants in fishes.
- ✓ Fluorescence in situ hybridization technique utilized for assessment of genetic diversity in 20 fish species.
- ✓ Completed cytogenetic profiling of 70 endangered and endemic freshwater fish species.
- ✓ Assessment of impacts of exotic fish species viz. Oreochromis niloticus, Clarias gariepinus, Pangasianodon sutchi and Piaractus brachypomus on indigenous fish biodiversity carried out.
- ✓ Developed pluripotent embryonic stem cell lines derived from Indian catfish, Heteropneustes fossilis and Labeo rohita embryos.
- ✓ Developed rapid DNA based diagnostic assays utilizing PCR for Gyrodactylus salaris, G. elegans, Dactylogyrus intermedius, Myxobolus cerebralis and M. clarii.
- ✓ Promoted a new concept of 'State Fish', which led to declaration of 14 fish species as State Fish by 17 States.
- ✓ Coordinating the implementation of DAHDF and NFDB supported National Surveillance Programme for Aquatic Animal Diseases in the country, carried out in 14 selected states of aquaculture importance, with involvement of 22 partner organizations.
- ✓ Developed diagnostic capability for OIE-listed pathogens of finfishes as well as shellfishes.
- ✓ Developed monoclonal antibodies against serum immunoglobulins of Channa striatus, Clarias magur and Catla catla, which have application in sero-surveillance and evaluating efficacy of vaccines.

- ✓ Developed cell lines from 16 commercially important food and ornamental fish species, which will have application in disease diagnosis. Also developed macrophage cell lines from catla and rohu which can be used as in vitro models for evaluation of immunomodulators.
- ✓ Developed cell lines from 16 commercially important food and ornamental fish species, which will have application in disease diagnosis. Also developed macrophage cell lines from catla and rohu which can be used as in vitro models for evaluation of immunomodulators.
- ✓ Established National Repository of Fish Cell Lines possessing 50 fish cell lines with financial support of Government of India.
- ✓ Contributed to the preparation of several policy documents for conservation and sustainable utilization of fish genetic resources, in collaboration with other institutes/agencies, viz., Guidelines for Germplasm Exchange; National Strategic Plan on Aquatic Exotics and Quarantine; National Exotics and Quarantine Guidelines; Guidelines for Green Certification for Freshwater Ornamental Fishes and Model guidelines for Fish and Shellfish Seed Certification in India.

More: http://www.nbfgr.res.in/

3. National Bureau of Agriculturally Important Microorganisms (NBAIM)


NBAIM Building, Mau (Uttar Pradesh)

National Bureau of Agriculturally Important Microorganisms (NBAIM), Uttar Pradesh was established through a funded project sponsored by the Department of Agricultural Research and Education (DARE), Ministry of Agriculture (Government of India) in the IX Plan in 2001 under the auspices of the Indian Council of Agricultural Research (ICAR). Initially, the bureau started functioning at Old NBPGR Building, New Delhi and then shifted to Kusmaur, Mau Nath Bhanjan, Uttar Pradesh on 1st June, 2004.The basic goal of the Bureau is to promote and coordinate systematic and scientific research in the area of agriculturally important microorganisms (AIMs) in order to improve the agricultural productivity. The Bureau houses National Agriculturally Important Microbial Culture Collection (NAIMCC) with more than 5000 microbial accessions isolated from different parts of the country. The vision of the Bureau is based on using its resources and experiences as a Microbial Resource Center to become the pioneer in the management of standard microbial reference materials, intellectual property resources and translational research as applied to the development, standardization and certification of biomaterial.

Objectives

- ✓ Exploration and Collection of Agriculturally Important Microorganisms (AIMs)
- ✓ Identification, characterization and documentation of AIMs
- ✓ Conservation, maintenance and utilization of AIMs
- ✓ Surveillance of indigenous/exotic AIMs
- ✓ Microbial diversity and systematics
- ✓ Human resource development

  More: http://nbaim.org.in/

4. National Centre for Integrated Pest Management (NCIPM), New Delhi

National Centre for Integrated Pest Management (NCIPM) of Indian Council of Agricultural Research (ICAR), India was established in February, 1988 to cater to the plant protection needs of different agro-ecological zones of the country. In spite of a large expert workforce across different plant protection disciplines, there are still epidemics of pests on different crops in the recent past with the chronic pest problems assuming serious proportions. The Centre has a strong institutional network in place to take on the challenges of plant protection in the country in a harmonized manner.

Research achievements

- Validated IPM technologies
- ✓ Cotton
- ✓ Rice
- ✓ Pulses
- ✓ Oilseeds
- ✓ Vegetables
- Forewarning systems & Distribution maps
- Databases and Softwares
- Mass production of bioagents

Mandate

- To develop and promote IPM technologies for major crops so as to sustain higher crop yields with minimum ecological implications.
- To develop information base on all aspects of pest management and to advise on related national priorities and pest management policies.

- To establish linkages and collaborative programmes with other national and international institutes in the area of IPM.
- To extend technical consultancies.

More: www.ncipm.org.in/

5. National Research Centre on Plant Biotechnology (NRCPB), New Delhi

The National Research Centre on Plant Biotechnology (NRCPB), established in 1985 by Indian Council of Agricultural Research (ICAR), is a premier institute engaged in research of national importance in the field of plant and agricultural biotechnology. Since its inception, NRCPB has progressed significantly focussing the efforts on major thrust areas such as genetic engineering for biotic resistance, exploitation of heterosis for enhancement of crop productivity, molecular breeding to unlock the genetic potential from diverse germplasm and integrate in cultivated crop varieties, various crop and microbe genome sequencing projects to the latest OMICS high throughput techniques which provide accessibility to engineer at several levels from genome to metabolome. The Centre kept pace with newer technologies through acquisition of technical skills and equipping with infrastructure to transform as state-of-the-art research centre.

Mandate

- To undertake Plant molecular biology research for understanding molecular mechanisms underlying basic biological processes.
- To devise tools and techniques of biotechnology for crop improvement.
- To apply the knowledge of genomics for advancing agricultural production.
- To serve as a national lead centre for plant molecular biology and biotechnology research and to create trained manpower in the area of plant biotechnology.

Achievements

Patents

Patent applications filed:-

The following applications were filed for patent rights by NRCPB.

A novel nematode-induced gall specific promoter from Arabidopsis thaliana (2586/DEL/2011) by Jain P. K, Kakrana Atul, Kumar Anil, Sirohi Anil and Srinivasan Ramamurthy

A novel root-specific and nematode-responsive promoter from Arabidopsis thaliana (2569/DEL/2011) by Jain P. K, Kakrana Atul, Kumar Anil, Sirohi Anil and Srinivasan Ramamurthy

A strategy for genetic engineering of male sterility and transgene containment in plants (41/DEL/2012) by Bhat Shripad Ramachandra, Srinivasan Ramamurthy and Kumar Pankaj

Promoters from Gossypium hirusutum for the over expression of foreign genes in cotton boll tissue (3079/DEL/2012) by Kumar Polumetla Ananda, Reddy Siva Vanga, Leelavathi Sadhu
Magnaporthe oryzae polynucleotide associated with rice blast resistance and uses thereof (398/DEL/2013) by Ray Soham, Sharma Tilak Raj
Complete patent application for invention titled "Rice polynucleotide associated with blast resistance and uses thereof" was filed on 4th February 2010 (no. 241/DEL/2010) by Dr. Tilak Raj Sharma and Dr. Alok Das.
Complete patent application for invention titled "Novel trichome specific promoter" was filed on 30th October 2009 (no. 2251/DEL/2009) by Dr. Srinivasan Ramamurthy, Vajinder kumar, Dhiraj Ramesh Thakre, Pradeep kumar jain and Sripad Ramchandra Bhat.
Complete patent application for invention titled "A process for developing the insect resistant dicot plant by homologous recombination mediated gene targeting" was filed on 2nd December 2009 (no. 2733/DEL/2008) by Dr. Polumetla Ananda Kumar, Monika Dalal, Deepty Shrivastava and Vikrant Nain.

Patent obtained:-
India Patent office granted a patent for the invention titled "Synthetic gene encoding a chiremeric δ-endotoxin of *Bacillus thurigiensis*". (Patent No. :237912)
India Patent office granted a patent for the invention titled "Synthetic gene encoding a cry1Fa1 S-endotoxin of *Bacillus thuringiensis*". (Patent No.:242768)
More: http://www.nrcpb.res.in/

6. Indian Institute of Spices Research (IISR), Kozhikode (Calicut)

The Indian Institute of Spices Research (IISR), Kozhikode (Calicut) a constituent body of Indian Council of Agricultural Research (ICAR) is a major Institute devoted to research on spices. In 1976, it started as a Regional Station of the Central Plantation Crops Research Institute (CPCRI), Kasaragod engaged in research on spices.

A National Research Centre for Spices was established in 1986 with its headquarters at Kozhikode, Kerala by merging the erstwhile Regional Station of CPCRI at Kozhikode and Cardamom Research Centre at Appangala, Karnataka. Realising the importance of Spices Research in India this Research Centre was upgraded to Indian Institute of Spices Research on 1st July, 1995.

Mandate

- To extend services and technologies to conserve genetic resources of spices as well as soil, water and air of spices agro ecosystems.
- To develop high yielding and high quality spice varieties and sustainable production and protection systems using traditional and non-traditional techniques and novel biotechnological approaches.
- To develop post harvest technologies of spices with emphasis on product development and product diversification for domestic and export purposes.
- To act as a centre for training in research methodology and technology upgradation of spices and to coordinate national research projects.
- To monitor the adoption of new and existing technologies to make sure that research is targeted to the needs of the farming community.

Research

The Institute provides research facilities related to spice crops, both Institute funded and externally funded. The objectives of the research programs span over:

- Collection, conservation, evaluation and cataloging of germplasm.
- Development of varieties of high yield, quality and resistance to biotic and abiotic stresses through conventional and biotechnological approaches.
- Standardizing propagation methods to ensure large scale production and distribution of high yielding genotypes
- Development of agrotechniques for increasing production and productivity.
- Integrated pest and disease management.
- Post harvest technology.
- Socio-economic aspects of cultivation, marketing and information dissemination in spices.
- Investigation on nutraceuticals and pharmacokinetics aspects of spices.

More: http://www.spices.res.in/

7. Central Institute for Cotton Research (CICR), Nagpur

Central Institute for Cotton Research (CICR) institute established (in 1976) by the Indian Council of Agricultural Research to promote long term research efforts in cotton production and provide support and conduct applied research on cotton with the active involvement of State Universities.

Mandate

- To conduct basic and strategic research on cotton to improve yield, fiber quality and by products
- To create new genetic variability for location specific adoption in cotton-based cropping systems

- To Collect, conserve, evaluate and cataloguing of Cotton germplasm
- Development of appropriate farming/cropping system for different cotton growing zones and their effective soil fertility management
- Development of effective and efficient disease and pest management strategies
- To coordinate network research with state agencies
- To assist in transfer of modern cotton production technology to various user agencies
- To extend consultancy and links with international agencies to accomplish the above mandate.

Research activity

Crop Improvement

- Participating of CICR in the Cotton Genome Sequencing
- Big Boll Cotton Culture Developed
- Fruiting behaviour in Egyptian Cotton Gossypium barbadense L.
- Implementation of PPV & FR Act, 2001 : Our preparedness
- Detopping with defoliation treatment : maximizes seed yield in cotton
- Extension of shelf life of cotton (Gossypium hirsutum) seeds through polymer coating

Crop Production

- High density cotton planting for improving rainfed cotton productivity in vidarbha
- Contingency plan for the management of drought situation
- Cotton based multi tier intercropping system
- Integrated Nutrient Management with In-situ green manure in Cotton
- Post Harvest assessment on Soil Fertility - a key to BMPs
- Sustainability of cotton in problematic soils
- Nutrietnt Potential of Organic Sources for Soil Fertility Management in Organic Cotton Production
- Polyethylene mulching for cotton based cropping system
- Micro Irrigation for cotton cultivation

Crop Protection

- Development of a Trichoderma formulation for management of root diseases in cotton
- Identification of sclerotium delphinii causing seed rot and seedling rot in cotton
- Insecticidal toxin secreted by bacterial symbionts of native Entomopathogenic Nematodes.
- Mirid Bug, Creontiodes biseratense (Distant) damage on Cotton in Coimbatore
- Isolation of Pink Pigmented Facultative Methylotrophs (PPFM) from cotton phyllosphere
- Mite Pests of Cotton
- Role of forewarning insect pests in IPM
- Cotton pests, predators and parasitoids : Descriptions and seasonal dynamics
- Bio control basd Cotton IPM
- List of Insect and Mite Pests of Cotton in India
- Pest Control in Organic Cotton
- Biology of the mealybug, Phenacoccus solenopsis on cotton in the laboratory
- Laboratory evaluation of insecticides and biopesticides against Phenococcus solenopsis and Paracoccus marginatus infesting cotton

Social Science

- Cotton Production in India - Current Scenario
- Chronology of Bt Cotton in India
- Contract Farming venture of Cotton in Tamil Nadu
- Socio Economic Analysis of Organic Cotton
- Problems and Prospects of Cultivation of Bt Hybrids in North Indian Cotton Zone

Post Harvest Technology

- Quantitative and Qualitative Requirements of Cotton for Industry
- Extraction, Profiling and Use of Cotton-Seed Oil
- Pulp, Paper and Corrugated Boxes from Cotton Stalks
- Boll Rind Hardness Tester
- Absorbent Cotton from Non-Spinnable Fibres by Eco-Friendly Means
- Blended Textiles for Niche Market From Natural Fibres
- Edible Oyster Mushrooms on Cotton Plant Stalks
- Production of Biogas from Willow Dust
- Production of Compost from Ginnery Waste

More: http://www.cicr.org.in/

8. Central Sheep and Wool Research Institute, Rajasthan

The Central Sheep and Wool Research Institute is a premier Institute of Indian Council of Agricultural Research (ICAR) engaged in research and extension activities on sheep and rabbits. It was established in 1962 at Malpura in Rajasthan. The institute engaged in research, training and extension activities on sheep and rabbits.

Mandate

Basic and applied research on sheep and rabbit production, health, utilization, training and transfer of technologies to the beneficiaries.

Objectives

- To undertake basic and applied research on all aspects of sheep and rabbit production.
- To develop, update and standardize meat, fibre and pelt technologies.
- To impart trainings on sheep and rabbit production and utilization.
- To transfer improved technologies on sheep and rabbit production to farmers, rural artisans and development workers.
- To provide referral and consultancy services on production and products technology of sheep and rabbits.

Research and achievements

- Supply of superior germplasm to the sheep breeders which has improved the body weight of progeny by 5.95% to 14.92% at different growth stages and greasy fleece yield has increased by 14.92%.

- Production of extra lambs through application of advanced reproduction technologies like synchronization of estrus, artificial insemination and treatment of anoestrus animals in the farmers' flock has increased the income of the sheep breeders.
- A total of 859 field demonstrations were conducted on farmers' fields for Horti-pasture, silvi-pasture and agro-forestry systems in order to ensure round the year fodder availability.
- Importance of nutritional supplementation of weaner lambs for higher meat production was demonstrated, where average body weight of supplemented lambs was 10.40 Kilograms higher than non supplemented at finishing age. Nutritional supplementation at critical physiological stages has been demonstrated where, the lambing rate in flushed ewes were higher by 10% as compare to non flushed ewes and the average milk yield was 116-340 grams higher in supplemented ewes than non supplemented ewes.
- Mortality rate has been reduced from 20% to 5% in the flocks of sheep breeders in the Institute adopted villages through Institute recommended health care practices.
- Training of local artisans for manufacture of handmade namda (felt) from indigenous wool and handloom carpet was undertaken. Consultancy on felt, woolen textiles and shawl making was given to industry. Wool and nylon blended carpet as developed.
- Superior germplasm of broiler rabbits were provided to the farmers from different part of the country and 78 farmers from different states were technically supported for establishment of new units.
- A total of 25 Exhibitions were stalled for demonstration of Institute technologies in different organizations, 115 Exposure visits for farmers, 27 field days, 178 press notes,3 sheep melas and 15 Television programmes were organized during the period. Linkages with State and Central Government Organizations, farmer groups and NGOs etc. were established. Technical literatures in the form of Prasar Patra, Leaflets, Pamphlets, technical bulletins, posters, documentary videos on institute technologies were developed and radio talks and TV interviews were given.

More: http://www.cswri.res.in/

9. National Agricultural Bioinformatics Grid (NABG), New Delhi

National Agricultural Bioinformatics Grid (NABG) is a National initiative taken by the Indian Council of Agricultural Research (ICAR) to strengthen bioinformatics research and development programs in NARS system. The field of bioinformatics focuses on developing and applying computationally intensive techniques (e.g., pattern recognition, data mining, machine learning algorithms, and visualization) which gives the opportunity to quickly and efficiently study heap of genomic information, chemical structure and other biological data. Bioinformatics has already started showing its profound impact on agricultural research and development. NABG will help Indian scientists to solve the problems of uncovering wealth of biological information truly uncovered within the biological system in various subject domains including microbial research.

Objectives

- Development of agricultural bioinformatics grid for the country.
- Creation of local databases and Bioinformatics Data Warehouse (BinDW) for genomic resources across species.
- Human resource development in agricultural bioinformatics.
- Create and promote inter-disciplinary research groups with focus on agricultural bioinformatics.

Major Activities of Lead Centre

- Designing and standardization of database structure and schema for collection and retrieval.
- Providing technical support for designing and development of data bases at domains and associated institutions in their respective area.
- Providing technical support for the analysis and mapping of genomic data at domains and associated institutions.
- Establishment of bioinformatics data warehouse (BinDW) and web based information system on biological resources in agriculture.
- Setting up of National Agricultural Bioinformatics Grid and biological data repository.
- Provide linkages with national and international organizations to facilitate collaborative research.
- Training for up-gradation of teaching and research skills in the field of agricultural bioinformatics.

Major Activities of Domain Centres

- Design and development of data bases of respective domain.
- Collection, compilation , annotation and storage of genomic data from various sources in the respective domains.
- Storage, maintenance, verification and quality assurance of genomic information collected from all sources of the domain.
- Identification of issues on bioinformatics and related fields in the domain.
- Provide support to the associated institutions for conducting research and experiments in the domain.
- Provide linkages with national and international organizations to facilitate collaborative research in domain.
- Establish linkages with main centre and domain nodes.
- Capacity building for conducting research in their respective domain.

More: http://nabg.iasri.res.in/index.html

10. Indian Veterinary Research Institute (IVRI), Iztanagar

Established in 1889, the Indian Veterinary Research Institute (IVRI) is one of the premier research institutions dedicated to livestock research and development of the region. The institute with faculty strength of more than 275 has a major mandate of research, teaching, consultancy and technology transfer activities. The institute with its long scientific heritage has always enjoyed a certain prestige, a tradition all of its own. The institute imparts quality post-graduate education to students not only from various parts of the country, but also from overseas. Today, the institute with its deemed to be university status contributes immensely to human resource development in the discipline of veterinary sciences with skills and knowledge necessary for the challenges of the new millennium.

Mandate

- To conduct research, provide postgraduate education and transfer of the technology in all areas of animal sciences with emphasis on animal health and production.
- To act as national referral centre for veterinary type cultures, disease diagnosis, biologicals, immunodiagnostics, etc.

Research activities

A. Self-reliance in cutting-edge and frontier technologies in research and human resource development.
B. Development of quick and precise methodologies including kits for diagnosis of diseases/ conditions, package of practices for optimum animal health.
C. Surveillance, creation of data bank and forecasting system of animal diseases.
D. Improvement of immunoprophylactics, use of biotechnological tools in evolving vaccines for important diseases of livestock and poultry.
E. Pet animal health and disease management.
F. Disaster management for livestock through multidisciplinary approach.
G. Genetic studies on disease resistance in domestic species of livestock.
H. Monitoring and surveillance of drugs, pesticides, mycotoxins and microbial residues in livestock and livestock products.
I. Pharmacological evaluation of herbs/plant products and promotion of ethno-veterinary medicine.

J. Harnessing techniques for in vitro fertilization, cloning of embryos and research on transgenic animals and stem cells.
K. Development of economic diets and nutrition for health and wellbeing of farm animals and pets.
L. Processing and preservation of meat and development of value-added meat products.
M. Farming systems based research and extension activities for livestock-buffalo, cattle, goat, sheep and pigs.
N. Evaluation, refinement and transfer of technologies.
O. Livestock economics, creation of databases for livestock and related statistics, impact analysis and market intelligence.
More: http://ivri.nic.in/

11. National Dairy Research Institute, Karnal

The National Dairy Research Institute, Karnal was originally started as Imperial Institute of Animal Husbandry and Dairying in 1923 at Bangalore. It was expanded and renamed as Imperial Dairy Institute in 1936 and was known as National Dairy Research Institute after independence in 1947. Subsequently, in 1955, NDRI headquarters was shifted to Karnal. Dairy Research institution has developed considerable expertise over the last five decades in different areas of Dairy Production, Processing, Management and Human Resource Development. Information generated at the Institute and the services offered have contributed to the growth of Dairy Industry as a whole and well-being of millions of milk producers and consumers of milk and milk products.

Research Activity

- Two strains of cattle, namely Karan Swiss and Karan Fries developed by crossbreeding, followed by selection.
- Cytogenetic profiles of various breeds of cattle, buffaloes and goats elucidated .
- Development of Hansa test for detection of adulteration of cow milk with buffalo milk.
- Development of 'Degcure' for curing Degnala disease.
- Urea-molasses block lick development for use as a good source of nitrogen and minerals to cattle during scarcity period.
- Protocol for induction of lactation in indigenous cows and buffaloes development.
- Procedures development and standardized for estrus synchronization and super ovulation different hormone combinations in cattle and buffaloes.

- Ten calves produced from a single donor cow in one year's time through ETT.
- Protocol for embryo transfer technology standardized for cattle and buffalo
- The world first in vitro fertilized buffalo calf born at NDRI. Since then more buffalo calves using this technology have been produced.
- Protocols for transferring IVF goat embryos to synchronized recipient goats using laparoscopy standardized resulting in the birth of first in vitro fertilized goat kid in the country at NDRI.
- A large animal treadmill for cattle and buffaloes fabricated for experimentation on work capacity to determine draught animal power in bullocks. This treadmill is the only one of its kind in India and South East Asia.
- Highly sensitive antiserum against progesterone has been development.
- Development/standardization of processes and techniques for the manufacture of concentrated milk product such as sweetened condensed and evaporated milks from buffalo milk.
- Development of powdered products such as milk powder, Rasogolla powder, gulabjamun mix powder and low-lactose milk
- Development of processes for manufacturing of low fat, sugar free desserts & Rasogulla using artificial sweeteners and bulking agents.
- Development of different varieties of beverages including sports drinks using whey.
- Simple, accurate and rapid methods for estimation of major and minor constituents, heat stability tests and detection of adulterants etc., for milk and milk products such as "synthetic milk" adulteration in milk Development of a process for production of low cholesterol ghee.
- Innovations in lactometer design and a for estimation of SNF in milk to suit Indian conditions.
- Test kit for detection of various adulterants in milk.
- PCR test kit development for detection of food borne pathogens in milk and milk products.
- Development of continuous ghee, and channa making machines. Cream separator attachment for domestic mixies and food processors.
- Development of process for conversion of ghee into recombined Butter (Butter G).
- Development of a composite management index for bovines as a determinant in enhancing milk production.
- Development of a test for measurement of adoption behavior of dairy farmers, training effectiveness index and skill competence scale.

More: http://www.ndri.res.in/

12. Indian Institute of Plantation Management, (IIPM) Bangalore

Indian Institute of Plantation Management, (IIPM) Bangalore was prepared. Realizing the potentialities and needs of modernization of the plantation sector through management education and training, the Ministry of Commerce & Industry, Government of India constituted a core group in 1990 to set up a strategic institution of management education in the plantation sector. The Institute is today a centre of excellence which acts as a think tank and an intellectual resource base for the plantation and associated agri-business sector. It is an exclusive sectoral school of management based on a new model of intensive institute-industry interaction. Institute has a strong research focus on policy, managerial and operational issues. Institute has been undertaking research projects in frontier areas of concern at the industry, national and global levels, sponsored by corporate organizations, national and international bodies.

Research activities

- Global Competitiveness of the Plantation Industry
- Productivity & Quality
- Market Structure, Market Intelligence and Market Information
- Brand Building and New Product Innovation
- E-Commerce, National Commodity Information Grid
- Improving Competitiveness of Micro Enterprises
- Sustainable Plantation Management
- Estate Performance Agreement Systems
- Commodity Futures
- Extension Management and Grassroots Institution building
- Agri-business Development
- Social Development Contribution of Indian Plantation Industry
- HRD and Work Culture Development
- Social Concerns of Plantation Industry: Absenteeism, Alcoholism, etc.
- Knowledge Management in Plantation Industry
- Risk Management
- Cost Competitiveness

More: http://www.iipmb.edu.in/

13. Indian Institute of Agricultural Biotechnology (IIAB), Ranchi

Indian Council of Agricultural Research (ICAR), the apex body for agricultural research in the country took the initiative to set up Indian Institute

of Agricultural Biotechnology (IIAB). This institute, slated to be a demand university interfacing plant, animal, fish and microbial biotechnology under a single umbrella. The IIAB will lay emphasis on the emerging areas of Genomics, Bioinformatics, Molecular Breeding, Molecular Diagnostics, Genetic Engineering and Nano-biotechnology for providing quality higher education.

Mandate

- Serve as national of excellence in Agricultural Biotechnology for undertaking cutting edge research, post graduate, doctoral and post doctoral education and capacity building
- Create platform for interaction and networking of national and international institutions for the application of Biotechnology in agriculture and provide appropriate support for policy framework.
- Forge partnerships with different stakeholders for the development and delivery of products and processes of Agricultural Biotechnology.
- Entrepreneurial and other relevant areas for furthering the application of agricultural biotechnology.

More : http://ilri.ernet.in/~iiab

14. Indian Institute of Horticultural Research, Bengaluru

The Institute spread its sphere of Research activities to the length and breadth of the Nation by establishing its experimental stations at Lucknow, Nagpur, Ranchi, Godhra, Chettalli and Gonikopal. Over the years these experiment stations have grown in size and today they stand as independent institutes, however, retaining the Chettalli and Gonicoppal under its fold. As of now, the IIHR has its main research station at Hessaraghatta, Bengaluru with 263 ha of land and Regional experiment stations at Bhuvaneshwar in Orissa and Chettalli in Karnataka with two Krishi Vigyan Kendras both located in Karnataka state at Gonikopal in Kodagu and Hirehalli in Tumkur districts. Apart from this the Project Coordinating Cell of the All India Coordinated Research Project on Tropical Fruits is also located at the institute at Bengaluru.

Mandate

1. To undertake basic and applied research for developing strategies to enhance productivity and utilization of tropical and sub-tropical horticulture crops viz., fruits, vegetables, ornamentals, medicinal and aromatic plants and mushrooms.
2. To serve as a repository of scientific information relevant to horticulture.
3. To act as a centre for training for up gradation of scientific manpower in modern technologies for horticulture production and
4. To collaborate with national and international agencies in achieving the above objectives

More: http://www.iihr.ernet.in/

15. Indian Institute of Pulses Research (IIPR), Kanpur

Indian Institute of Pulses Research (IIPR) is a government institute in Kanpur, Uttar Pradesh. It was established in the year 1983 by the Indian Council of Agricultural Research (ICAR) to carry out basic strategic and applied research on major pulse crops. It is situated on Grand Trunk Road and is about twelve kilometer from Kanpur Central Railway Station towards New Delhi. The overall climate varies from semi-arid to sub-humid and mean annual rainfall ranges from 800 to 1000mm. The Institute is involved in generation of basic information, development of high yielding varieties and appropriate production and protection technologies, production of breeder seeds, demonstration and transfer of technologies, and strategic coordination of pulses research through wide network of testing centres across the country.

Mandate

- To act as national centre for basic and applied research on pulse crops
- To monitor, guide and coordinate research on pulses in the country
- To impart training to scientists and extension workers engaged in pulses research and development
- To foster national and international collaborations for exchange of views and material
- To disseminate information on latest pulses production technology
- To serve as an information bank on different aspects of pulses for strategic planning
- To extend consultancy services and expertise

Research

The Institute develops appropriate production and protection technologies, production and supply of breeder seeds of improved varieties, demonstration and transfer of technologies and strategic coordination of pulse research through wide network of testing centers across the country

More: http://www.iipr.res.in/

16. Central Plantation Crops Research Institute (CPCRI), Kerala

The Coconut Research Station at Kasaragod in Kerala was initially established in 1916 by the then Government of Madras and subsequently it was taken over by the Indian Central Coconut Committee in 1948. Central Plantation Crops Research Institute (CPCRI) was established in 1970 as one of the agricultural research institutes in the National Agricultural Research System (NARS) under the Indian Council of Agricultural Research (ICAR).

Mandate
The Institute had the mandate to undertake research on coconut, arecanut, cocoa, cashew, oil palm and spices at the time of establishment. The research on cashew, oil palm and spices were later delinked from CPCRI to form separate institutes. The present mandate of the institute is to conduct research on coconut, arecanut and cocoa.

Research achievement
Crop Improvement
Crop Production
Crop Protection
Plant Physiology Biochemistry and PHT
Social Science
More : http://www.cpcri.gov.in/

17. National Bureau of Agricultural Insect Resources (NBAIR), Bangalore

National Bureau of Agricultural Insect Resources (NBAIR), formerly National Bureau of Agriculturally Important Insects (NBAII) is located in Bangalore, Hebbal in the same premises at which The Commonwealth Institute of Biological Control (CIBC), Indian Station was established in 1957. The advent of CIBC marked the beginning of organized and systematic biological control research in India.

Mandate
To act as a nodal agency for collection, characterization, documentation, conservation, exchange and utilization of agriculturally important insect resources (including mites, spiders and related arthropods) for sustainable agriculture.

Achievements
Classical Biological Control of the PAPAYA mealybug

Biological control of the Sugarcane wooly aphid
More : http://www.nbair.res.in/

18. National Research Centre for Agroforestry (NRCAF), Jhansi

The National Research Centre for Agroforestry (NRCAF), as unit of ICAR was established in 1988. The Centre is located at Jhansi in Uttar Pradesh, about 10 Kms from Jhansi Railway Station and is popularly known as "KRISHIVANIKI". The centre is in process of developing phase and modernizing its infrastructure. Its magnificent office building and residential quarters are situated opposite to Pahuj Dam, Gwalior Road, Jhansi. Now it is renamed as Central Agroforestry Research Institute (CAFRI).

MANDATE

- To under take basic and applied research for developing and delivering technologies based on sustainable agroforestry prctices on farms, marginal and wastelands for different agroclimatic zones in INDIA.
- To co-ordinate network research with the SAUs/ ICAR Institutes/ other related research institutes for identifying technologies which can be transferred from one region to another.
- To provide training in (a) research methodologies and (b) use and application of technologies developed at various levels.
- To develop technological packages of diffrent agroforestry practices for various agroclimatological zones for transfer to farm field and wastelands.
- To act as repository of information on the subject.
- To collaborate with relevent national and international agencies for achieving the mandate.
- To provide consultancy.

Research Achievements

Agrisilviculture

- ✓ *Hardwickia binata* based agrisilviculture system developed and standardized for rainfed as well as irrigation conditions.
- ✓ In *Dalbergia sissoo* based agrisilvicultural system under irrigated condition, blackgram and mustard yield was significantly better under deep ploughing as compared to normal ploughing.
- ✓ At the age of five year, tree accumulated 34.50 t carbon/ha under naturally grown condition, 30.41 and 23.60 t carbon/ha under 50 and 70% canopy pruning in above and below ground biomass. N accumulation under 50%, 70% and naturally grown trees was 290, 222 and 325 kg/ha.
- ✓ Three species of Glomus, two species of Acaulospora, three species of Gigospora and two species of Scutellospora were frequently recorded in rhizospheres of aonla, ber, chironji and laoda. Inter-cropping increased VAM activities in agroforestry systems in comparison to pure tree plantation.
- ✓ *Eucalyptus tereticornis* based Agrisilculture, block plantation and boundary plantation showed significantly better above and below ground biomass in agrisilviculture than

block plantation. Tree geometry had significant influence on growth and yield of intercrop wheat.

Agrihorticulture

- ✓ Aonla (*Emblica ofiicinalis*) based agroforestry technology standardised for the development of degraded lands of Bundelkhand region. Aonla varieties Kanchan and NA-7 have been identified highly renumerative as they have potential to yield 120 kg fruit /tree at the age of 10 years.
- ✓ In-situ moisture conservation technique (stone mulching, deep basin, deep tillage+deep basin) significantly increased collar diameter of aonla plants and fruit yield. In 10th year of experimentation fruit yield ranged between 20.80 to 23.37 kg/plant under different conservation treatment against control (16.9 kg/tree).
- ✓ Vegetative propogation technique of aonla through softwood cleft grafting on 5-6 months old seedling raised in polybags showed high establishment of plant on field transplant.
- ✓ Bench grafting in aonla and ber, patch budding in bael and lasora and veneer grafting in chironji have been found highly successful.
- ✓ In hortipasture studies, 12 fruit tree species were evaluated under natural pasture. Aonla, Mulberry, Lasora, Imli, Bael and Ber were found quite adaptive and feasible on the basis of survival, growth and yield.

Silvipasture

- ✓ Biomass production from degraded lands could be enhanced to 8-10 t/ha/year from 2-3 t/ha/year by introduction of leguminious trees, shrubs and herbs in natural rangelands.
- ✓ Average daily gain in body weight of lambs and kids was higher (33 & 40%, respectively) under silvipasture system developed for semi-arid regions as compared to natural pasture during total grazing period of 478 days.
- ✓ Evaluation of grazing on improved silvipasture system revealed that 5 goats and 5 sheeps /ha can be reared throughout the year. In addition, kids and lambs can be retained upto 6 months with satisfactory growth. The practice is economically viable.

Tree Improvement & Silvipasture

- ✓ Techniques for asexual propogation of high priority agroforestry species such as Anogeissus pendula, Hardwickia binata, Madhuca latifolia, Tectona grandis, Albezia procera, Bambusa spp., Morus species, Azardirachta indica, Albezia amara, Dalbergia sissoo and Mela dubia have been standardized.
- ✓ Successful air layering in Hardwickia binata was achieved with 1000 ppm IBA + 500 ppm Kinetin + 50 ppm vitamin B complex resulting in 55% rooting during May. There was 100% survival in pots.
- ✓ Anogeissus pendula was successfully regenerated through air layering with the treatment of 800 ppm IBA
- ✓ Success achieved in propogation of Madhuca latifolia through air layering and stem cutting in the month of July and plants raised were successfully transferred to the field.
- ✓ In Neem provenance trial, provenances of Dabra, Damoh, Shivpuri and Bhopal maintained their superiority over Jhansi since the establishment of trial (1994). progenies PT-6, PT-7, PT-15, PT-27 and PT-13 were performing well when compared to check i.e. Jhansi.

- ✓ Out of 30 plus tree progeniesl of Dalbergia sissoo, progenies PT-2 and PT-6 proved thier superiority over check both in cultivated and degraded lands for growth and strightness.
- ✓ 160 accessions of Jatropha and twenty seven sccessions of Karanj have been collected from different states of the Country and being evaluated for growth, seed yields and oil content at the Centre as well as farmers' field.

Social Sciences, Watershed & HRD

- ✓ Studies on agri-horticultural system at farmers field with three fruit tree species namely *Zizyphus mauritiana*, *Citrus aurantifolia and Psidium guajava* at 6x6 m showed that yield of wheat was maximum in association with acid lime (2.2 t/ha) followed by *Z. mauritiana* (1.8 t/ha) and P. guajava (1.7 t/ha). The yield of groundnut was maximum in association with acid lime (0.4 t/ha) followed by *Z. mauritiana* and *P. guajava*. Fruit yield was maximum in *Z. mauritiana* (27.7 t/ha) followed by *P. guajava and C. aurnatifolia*.
- ✓ Dynamic database on agroforestry/ forestry in India has been developed and named as "agroforestryBASE". agroforestryBASE is an independent module and the components include database management at the backend and application program at the front end.
- ✓ In Research Projects Database, 199 agroforestry reasearch project covering 11 institutes and 25 agricultural universities have been entered. The database on MPTS (Multipurpose Tree Species) includes detailed information on 12 most important MPTS being utilised in agroforestry.
- ✓ Field survey in Pratapgarh district of Uttar Pradesh indicated that area under aonla plantation increased with a linear trend and the production almost doubled in about a decade. The compund growth rate in the district was 4.02 percent with that of its production was 5.2 percent. The infrastructure for aonla industry in Pratapgarh district is encouraging with about 56 nursaries and 24 aonla processing units.
- ✓ A watershed management programme has been initiated in Garh Kundar-Dawar, Dist. Tikamgarh (M.P.) on 850 ha area to demonstrate agroforestry technologies in participatory mode. Eight check dams were constructed to develop water resources. Marginal bunding of agricultural land (40 ha), gabion structures in 1st order stream (150 nos) were employed to check erosion. Agrihorticulture land use in 1.9 ha area on 5 farmers' field and live fencing on 1.7 ha are on 3 farmers' fiel were developed.
- ✓ The Centre regularly organises Farmers' Day, Kisan Ghoshties to acquaint the farmers training with the current achievements on agroforestry.

More: http://www.nrcaf.res.in/

19. National Bureau of Plant Genetic Resources (NBPGR), New Delhi

The establishment of the Bureau coincided with the advent of the Green Revolution and was in response to the realization of perceived effects of the Green Revolution on agrobiodiversity. Further, it was in accordance with the international developments in the form of establishment of the International Board for Plant Genetic Resources (IBPGR), Rome, in 1974 (now renamed as

International Plant Genetic Resources Institute). The NBPGR played a pivotal role in the improvement of various crop plants and diversification and development of agriculture in India through germplasm introduction from various institutes/organizations located in foreign countries and germplasm collection from within the country and abroad and conservation thereof.

Mandate

The Division of Germplasm Conservation is entrusted with the responsibility of conservation of Plant Genetic Resources for the posterity and sustainable use.

Achievements

Germplasm augmentation

The National Genebank conserves germplasm as per the genebank standards as base collections at –18oC. The crop-wise details of the various accessions conserved in National Genebank are listed below. The current germplasm holdings in the National Genebank in the form of orthodox seed is 3,96,189 representing 1,584 species. In addition, a total of 28,735 exotic accessions of different crop groups, namely, cereals (15,018), grain legumes (1662), oilseeds (1329), vegetables (7982), fibers & forages (961), medicinal & aromatic (38), spices (894) and millets (19)have been kept as voucher specimen in the medium-term storage module.

Registration of unique germplasm

Promising germplasm material with novel, unique, distinct with academic, scientific or applied value are being registered to facilitate flow of germplasm among the scientists working in the crop improvement programmes. A total of 1,049 unique accessions covering 183 species have been registered till date.

Restoration of germplasm from ICRISAT/IRRI and its conservation at NBPGR

Under a collaborative research project on restoration of germplasm of International Crop Research Institute for Semi-Arid Tropics (ICRISAT) mandate crops to NBPGR, a total of 2,980 accessions of different crops were received, out of which 424 accessions were found to be duplicates. The number of accessions restored till date is 56,223 with only 1,217 yet to be restored, the list of which has been compiled and sent to ICRISAT for necessary action. In addition, 11,718 accessions of rice were also restored from IRRI.

Monitoring, distribution and physical verification

Till date, more than 50,000 germplasm accessions conserved in the long-term storage module for 10 years or more have been monitored for seed viability, seed quantity and seed health to identify accessions that may require regeneration as per the genebank standards. In addition, more than 1,50,000 germplasm accessions of different crops have been supplied to various NARS partners for seed regeneration/ multiplication/ research/ evaluation.

Physical verification was performed by the Division of Germplasm Conservation during the 2009-2011, in order to verify the physical status, identifying the duplicates, updating the passport and other related information in database to enable it to link with the web-enabled central database of NBPGR.

National Permafrost Repository

An MoA has been signed between ICAR and Defence Research and Development Organization for the development of low-energy based conservation of plant genetic resources as safety duplicates in the National Permafrost Repository (NPR) at Chang-la, Leh-Ladakh, Jammu and Kashmir. NBPGR has initiated studies during 2011 in collaboration with DRDO on 19 crops and 23 varieties to study the suitability of perma frost facility on conservation of germplasm.
More: http://www.nbpgr.ernet.in/

Department of Biotechnology (DBT)

1. National Agri - Food Biotechnology Institute (NABI), Mohali, Punjab

National Agri - Food Biotechnology Institute (NABI) is an autonomous institute of the Department of biotechnology, Ministry of Science and Technology, Government of India, located in the Knowledge City at Mohali, Punjab. The institute aims at catalysing the transformation of agri - food sector in India.

Mission:

- To transform agri-food sector into globally rewarding and sustainable biotechnology-based enterprise through innovative solutions in primary and secondary agriculture including high-end food processing.
- To develop synergy among knowledge providers and investors in agri-food sector to carry innovations to marketplace.

Research activities

Agri-Biotechnology

i) Comparative genomics for gene discovery and function
ii) Molecular breeding
iii) Genetic resource prospecting

iv) Value added designer crops
v) Transgenic crops
vi) Association genetics
vii) Phenomics
vii) Metabolomics
viiii) Bioinformatics

Food Science & Technology
i) Food processing & technology
ii) Bioprocess engineering & energy optimisation
iii) Post harvest food stability
iv) Biochemistry & metabolic profiling
v) Flavours & dyes
vi) Food safety

Nutrition Science & Technology
i) Novel foods
ii) Nutrition for wellness
iii) Nutraceuticals
iv) Nutrigenomics and nutritional biology
v) Foods and nutrients for public health including biofortification,biosynthesis and molecular breeding
vi) Public health nutrition technologies
vii) Bioactives of nutritional value from plants & microbes
More: http://www.nabi.res.in/

2. National Institute of Animal Biotechnology (NIAB), Hyderabad,

The National Institute of Animal Biotechnology is an Indian (NIAB) autonomous research establishment in 2010 under the Department of Biotechnology, Ministry of Science and Technology (India). NIAB is located within the campus of University of Hyderabad, the Highest Ranked University in the country, in about 100 acres of land. NIAB is aimed to harness novel and emerging biotechnologies and take up research in the cutting edge areas for improving animal health and productivity. The Institute's focus of research will be on Animal Genetics and Genomics, Transgenic Technology, Reproductive Biotechnology, Infectious Diseases,

Bioinformatics and Nutrition Enrichment. The institute aims at translational research leading to the development of novel vaccines, diagnostics and improved therapeutic molecules for farm animals. The Institute plans to promote bio entrepreneurship by providing support environment for commercial tenants involved in the development of farm animal based products.

Mission: Development of sustainable and globally competitive livestock industry through innovative technology.

Research Areas

- Inflammation Biology
- Animal Genetics and Genomics
- Infectious Disease
    - Bacterial Disease
    - Viral Disease
    - Protozoan Disease
- Reproductive Biotechnology
- Genetic Engineering
- Bioinformatics

More : http://www.niab.org.in/Default.aspx

3. Centre for DNA Fingerprinting and Diagnostics, CDFD, Hyderabad

The Centre for DNA Fingerprinting and Diagnostics (CDFD) is an Indian Biotechnology research center, located in Hyderabad, India, operated by the Department of Biotechnology, Ministry of Science and Technology, Government of India.

Mandate

The Hyderabad based Centre for DNA Fingerprinting and Diagnostics (CDFD) has a mandate to translate the fruits of modern biology to benefit society and, this is clearly visible. The major service components of CDFD involve DNA fingerprinting, diagnostics, genome analysis and bioinformatics.

Basic research in overlapping frontier areas of modern biology, especially in the post genomic scenario, is an integral component of this institute.

Research activity

- In the diagnostics area, CDFD has increased the range of services provided, encompassing cytogenetic, biochemical and molecular diagnosis.
- The diagnostics laboratory at CDFD runs a new-born screening programme with a mission to prevent the development of genetic disabilities through early intervention and treatment.
- Given the burden of infectious diseases, in our country, CDFD is now moving into diagnosis and identification of microbial pathogens, particularly focussing on, to begin with, tuberculosis.
- Complete sequence of the human genome and information from other sources, such as expression data from microarrays, have produced enormous information base for researchers. The marriage between biology and computer science known as bioinformatics is an attempt to make sense of this colossal amount of data and extract the useful information out of it.
- CDFD has been designated as the Indian node for the European Molecular Biology Network and is the only node, other than one in China, outside Europe.
- It has got an unusually large number of software and databases for genome analysis with browsable databases at its website.
- Analysis of the data contained in DSMP will enable the investigator to arrive at an educated guess about the likely structure and therefore function of his protein.
- CDFD is making major effort to bring about synthesis of IT with Biotechnology by initiating new programs in bioinformatics.
- CDFD is also planning to initiate a national effort for generating SNP (Single Nucleotide Polymorphism) maps with specific reference to diseases such as malaria, tuberculosis and those caused by non-infectious agents.
- Several new activities in frontier areas of modern biology such as bacterial genetics, molecular pathogenesis, cancer biology and metastasis, computational biology, structural and functional genomics, immunology, gene expression and cell death, host-parasite interactions, cellular signaling, etc. have been initiated.
- Human resource development and training is another component which CDFD has been undertaking.
- To develop IT based manpower, CDFD has also introduced a bioinformatics-internship program for the graduates to learn bio-computing and provide knowledge based software tools in modern biology.

More: http://www.cdfd.org.in

5. Institute of Biores Development (IBSD), In

The Institute of Bioresources and Sustainable Development although registered in April, 2001,

under the Manipur Societies Registration Act, 1989, the regular activity of the Institute could be started only with the appointment of its first Director on 18th January, 2003 to achieve the following mission, goal and objectives.

Mission
Bioresources development and their sustainable use through biotechnological interventions for the socio-economic growth of the region.

Objective

- ✓ To set up the state of art biotechnology research facilities at Imphal which is at the centre of the Indo-Burmese Biodiversity Hotspot for sustainable development of bioresources using -tools of modern biology.
- ✓ To study and document the unique biodiversity of bio-geographic junction of the Indian and oriental landmasses.
- ✓ To develop biotechnological interventions for sustainable development and utilization of bioresources
- ✓ To undertake capacity building (human resource development) in bioresouces conservation and management.
- ✓ To generate technological packages for employments generation and economic progress of the region.
- ✓ To collaborate with other institutions/- organizations/- universities nationally and internationally in furthering research pursuits in bioresources.

More: http://ibsd.gov.in/

6. Rajiv Gandhi Centre for Biotechnology, Thiruvananthapuram

The Rajiv Gandhi Centre for Biotechnology (RGCB) is a growing phenomenon. Located in Thiruvananthapuram, the capital city of Kerala, RGCB began in 1990 amongst humble surroundings as a small charitable society called the Centre for Development of Education, Science and Technology (C-DEST). In 1991, recognizing its potential, the C-DEST was made a "Grant-in-Aid" institute of the Government of Kerala and renamed as Rajiv Gandhi Centre for Development of Education, Science and Technology (RGC-DEST), becoming the first institute in the country to be named after Sri Rajiv Gandhi, former Prime Minster of India. In quick time, the institute attained national and international recognition with leading discoveries and findings in medical and plant biotechnology. The institute also

received honors for being among the top PhD schools in biotechnology. In 2007 the Union Cabinet of the Government of India took the landmark decision to make RGCB a national research centre.

Vision

The Themes are a more general description of the areas within the field of disease biology that RGCB recognizes as important domains for targeted efforts involved in the institute's mandate, mission and vision. These Themes will allow the development of Strategic Goals, which are the specific target areas identified as priorities by RGCB. As implementation of the Strategic Plan goes forward, these Goals will be the actual areas of focus, activities, and resources. Some of these priority Strategic Goals will represent current strengths of RGCB while for others, the Institute will identify new directions for the field that will answer novel questions and require state of the art capabilities.

More: http://rgcb.res.in/

7. Institute of Life Sciences, Bhubaneswar

Institute of Life Sciences (ILS) is an autonomous institution of Department of Biotechnology, Government of India. The institute was established on February 11, 1989, under the administrative and financial control of Department of Science and Technology, Government of Orissa. It was brought under the fold of the Department of Biotechnology, Government of India in August 2002. It is situated in the heart of beautiful city of Bhubaneswar, in the eastern part of India.

ILS is a premier research institute in the area of life sciences and has highly competent faculty scientists actively engaged in advanced research covering infectious disease biology, gene function and regulation and translational research. It has state of

the art infrastructural facilities (instrumentation, library, animal facility, high bandwidth internet and computational facilities) for cutting-edge multidisciplinary research in frontier areas of life science research. Currently, ~100 research scholars are working at ILS in various spheres of life sciences. ILS has on-campus residential facilities for the students with in-house dining and facilities for sports and other recreational activities. The ILS buildings are designed to provide convenient access to all areas for differently abled people.
More: https://www.ils.res.in/

Department of Science and Technology (DST)

1. Agakar Research Institute, Pune.

Agharkar Research Institute (ARI) is an autonomous institute of the Department of Science and Technology (DST), Government of India. It was established in 1946 as Maharashtra Association for the Cultivation of Science (MACS) and was registered under the Societies Registration Act. 1850. Later, as the research activities started expanding, the MACS Research Institute was given a separate identity. The institute was renamed as ARI in 1992 to honour its founder Director, late Professor S. P. Agharkar. The current research and development activities

of ARI span across all areas of life sciences spread over six different themes, namely Biodiversity & Paleobiology, Bioenergy, Bioprospecting, Developmental Biology, Genetics & Plant Breeding, and Nanobioscience.

Research activity

The Department is actively involved in research in the following thrust areas of Microbiology in tune with national funding agencies.

Microbial Biochemistry and nanotechnology

Molecular Biology

Environmental Biotechnology

More: http://aripune.org/

2. Kerala Forest Research Institute (KFRI)

Kerala Forest Research Institute (KFRI) is a multidisciplinary team of experts conducting research on tropical forests and forestry. This Institute has contributed significantly to research in tropical forestry and biodiversity conservation over the past three decades of its existence. Founded in 1975, Institute is envisioned as a Centre of Excellence in Tropical Forestry to provide scientific support for decision making on matters related to forestry, with particular emphasis on conservation, sustainable utilization and scientific management of natural resources. KFRI became a part of the Kerala State Council for Science, Technology and Environment (KSCSTE) along with five other R&D Centres of the State, when the KSCSTE was constituted in 2002.

Research activities

- ✓ Developed and standardised vegetative and micropropagation techniques for superior selections in teak, eucalypts, bamboo and various medicinal plants. KFRI was the first to standardise a methodology for clonal propagation of teak.
- ✓ Developed Biological control mechanism for controlling Teak Defoliator using HpNPV and mass production of the virus
- ✓ DNA mapping and genetic improvement of teak and developing clonal technology for production of improved planting stock of teak
- ✓ Productivity improvement of Eucalypt plantations through clonal technology, disease resistant provenances and sylvicultural practices.
- ✓ Standardised fertiliser dosages for teak and eucalypt plantations and assessment and augmentation of micronutrient deficiencies
- ✓ Preservative/curing treatments for rubber wood bamboos and canes for improved quality value addition and durability
- ✓ Root-trainer technology, compost media and micro and macro propagation techniques for bamboos, canes, selected medicinal plants and forest trees
- ✓ Developed plantation technology for more than 15 indigenous tree species, bamboos and rattans

More : http://www.kfri.res.in

3. Bose Institute, Kolkata

Bose Institute is a research institute in the fields of Physics, Chemistry, Plant biology, Microbiology, Biochemistry, Biophysics, Animal physiology, Immunotechnology, Bioinformatics and Environmental science. The institute was established in 1917 by Acharya Jagdish Chandra Bose, who was the founder of modern scientific research in India. Bose Institute pioneered the concept of inter-disciplinary research in India in synch with global trends. Its alumni have achieved renown in India and the world.

Major Research Areas

Astrophysics & Cosmology
Astrophysics around black holes, Cosmology, Observational Astrophysics

Chemical, Biological & Macro-Molecular Sciences
Study of complex molecular and hybrid systems (including biomolecules) using Experiments and Simulations, ultrasensitive & ultrafast spectoscopy techniques.

Condensed Matter Physics and Material Sciences
Experimental, theoretical and computational studies on Physics of materials, from nano dimension to bulk, Nanolithography and devices

Theoretical Sciences
Gravity, Quantum Field Theory, Lattice Gauge Theory, Granular Physics, Cognitive Science, Mathematical Physics, Statistical Physics, Nonlinear Physics, Quantum Optics and Quantum Information.

More: http://newweb.bose.res.in/

4. Institute of Advanced Study in Science and Technology, Guwahati, Assam

Institute of Advanced Study in Science and Technology (IASST) is a premier scientific research organization in the north-east region, conceived and nurtured by the Assam Science Society in its initial years and was inaugurated by Nobel Laureate Dorothy C. Hodgkin on 3rd November 1979. Subsequently, it was supported by the state govt. as its only autonomous R&D institute till March 2009. The institute was taken over in March, 2009 by the Ministry of Science and Technology, Govt of India as one of its autonomous R&D institute.

Research Theme
The Institute is engaged in multi disciplinary research activities, both in fundamental and applied, across frontier areas of science and technology such as Plasma physics, Polymer Sciences, Biochemistry, Drug design & development, Nano-science, Medicinal plants, Seri biotechnology, Microbial biotechnology, Environmental Sciences, Microbial Fuel Cell etc.
More: http://iasst.gov.in/

5. Indian Association for the Cultivation of Science (IACS), Kolkata

Indian Association for the Cultivation of Science (IACS) is an institute of higher learning in Kolkata, India. Established in 1876 by Mahendra Lal Sarkar, a private medical practitioner, it focuses on fundamental research in basic sciences. It is India's oldest research institute.

Located at Jadavpur, South Kolkata beside Jadavpur University, Central Glass and Ceramic Research Institute and Indian Institute of Chemical Biology it is spread over a limited area of 9.5 acres.

The institute is engaged in fundamental research in various fields of physics, chemistry and chemical biology. It is one of the most active research institutes in India and publishes on an average ~ 500 research articles in peer reviewed journals including top journals like Physical Review Letters, Journal of American Chemical Society and Angew. Chem. Int. Ed. Recent interests include research in energy, fuel cells, nano materials like graphene and carbon nanotubes. The institute emphasizes PhD programmes, the degree being provided either by Jadavpur University or by University of Calcutta.

http://www.iacs.res.in/

6. Institute of Nano Science And Technology, Mohali (Punjab)

Institute of Nano Science and Technology (INST), Mohali (Punjab), an autonomous institution of Department of Science and Technology (DST), Government of India, has been established under the umbrella of NANO MISSION, initiated by DST to boost research and development in the field of Nanoscience and Nanotechnology in India. INST started its activities on 3rd January 2013, the date on which its first Director was appointed. The institute is currently operating from its transit campus at Habitat Centre, Sector-64, Phase-X, Mohali, Punjab. The new campus of INST would be set up on 35 acers of land in the Knowledge City at Sector-81 (Mohali, Punjab), next to IISER Mohali campus, which is very near to new Chandigarh International Airport. INST, amongst other scientific institutions of Chandigarh and its nearby area is also part of

Chandigarh Region Innovation and Knowledge Cluster (CRIKC), an initiative of Punjab Government to foster and sustain close academic alliances between institutions of higher education and research in the Chandigarh region.

Vision

To emerge as globally competitive India's foremost research institution in Nano Science and Technology and to contribute to the society through application of nanoscience and nanotechnology in the field of agriculture, medicine, energy and environment.

Mission

To be a world class research institution by creating state-of-the-art infrastructural facilities, engaging outstanding scientists from different branches of science and engineering, encouraging them to carry out their individual scientific research to be published in the best journals along with their mandate to jointly work on interdisciplinary projects to develop devices/technologies based on nano science and technology. To encourage all aspects of nanoscience and nanotechnology with major thrust on the following areas: agricultural nanotechnology, sensors, medical nanotechnology, nanotechnology based solutions for energy and environment.

Objectives

- Resource building – Infrastructure and Manpower
- Enhance research activity in Nano Science and Nano Technology
- Training students in PhD programme in Nano Science and Technology
- Foster interactions between leading scientists of the world in Nano Science & Technology
- Impart advanced training courses & laboratory techniques of nanotechnology at the highest level
- Organizing important national and international level seminars and conferences
- Encouraging innovative and challenging technology/product based scientific projects
- Publish scientific papers of high impact factor
- Generating patents in Nano Science and Technology
- Setting up of incubators for translational research (from laboratory to industry)
- Sensitizing public and media about the advantages and safeguards in Nano Science and Technology


Energy
Energy Harvesting
Thin films
Environment
H2 Fuel Cells
Nano Structuring
Nanoscale Phenomena
Water Purification
Rural Development
Tailoring Properties
Sensing
VISION
Agriculture
Toxicology
Medicine
Diagnostics
Pest Control
Therapeutics
Drug Delivery

OTHER INSTIUTES

National Institute of Science Education and Research (NISER)

The academic programmes at NISER are deemed to be conducted through the Institute of Physics, Bhubaneswar, which is affiliated to Homi Bhabha National Institute (HBNI, a deemed to be university), Mumbai and is a grant-in-aid institution, under the Department of Atomic Energy. This arrangement will be in place until the formalities, of granting NISER the Constituent Institution (CI) status of HBNI is completed. NISER offers the following programmes in the Schools of Biology, Chemistry, Mathematics and Physics.

NISER recognizes that modern scientific research is carried out in interstices amongst fuzzy domains and blurred boundaries. This entails encouraging a new scientific culture where members of our community attain to an intellectual agility unconstrained by the limitations of disciplinary conventions from the past. Faculty and Students will be given generous material support in the pursuit to realize this objective.

http://www.niser.ac.in/

Indian Institutes of Science Education and Research (IISERs)

The Indian Institutes of Science Education and Research (IISERs), are a group of premier science education and research institutes in India. These institutions have been declared by Act of Parliament as institutions of national importance and are intended to be the IITs of basic sciences. The institutes were created by the Government of India, through the Ministry of Human

Resource Development (MHRD). Seven IISERs have been established across the country, namely IISER Kolkata in West Bengal, IISER Pune in Maharashtra, IISER Mohali in Punjab, IISER Bhopal in Madhya Pradesh, IISER Thiruvananthapuram in Kerala, IISER Tirupati in Andhra Pradesh and IISER Berhampur in Odisha. The IISERs represent a unique initiative in India where teaching and education are totally integrated with state-of-the-art research nurturing both curiosity and creativity in an intellectually vibrant atmosphere of research. Each IISER is an autonomous institution awarding its own Masters and Doctoral degrees

Indian Institutes of Science Education and Research (IISERs) Kolkata, West Bengal

Mission and Vision

The basic idea of IISER is to create research Universities of the highest calibre in which teaching and education will be totally integrated with the state of the art research. These Universities are devoted to Undergraduate and Postgraduate teaching in sciences in an intellectually vibrant atmosphere of research. One of the important objectives of creating these Universities is to make education and careers in basic sciences more attractive by providing opportunities in integrative teaching and learning of sciences and break the barriers of traditional disciplines.

Research and Development

Focusing on the vision of IISER Kolkata, cutting-edge research on basic and applied sciences and creating state-of-the-art research infrastructure are our top-notch priorities. Research at IISER Kolkata focuses on five major disciplines: Biological Sciences, Chemical Sciences, Earth Sciences, Mathematics and Statistics, Physical sciences, and also in the interdisciplinary areas connecting two or more of these disciplines.

More: www.iiserkol.ac.in/

Indian Institutes of Science Education and Research (IISER) Pune, Maharashtra

Vision

- Establish scientific institutions of the highest caliber where teaching and education are totally integrated with state-of-the-art research
- Make learning of basic sciences exciting through excellent integrative teaching driven by curiosity and creativity
- Entry into research at an early age through a flexible borderless curriculum and research projects

Research

IISER Pune is a research-intensive teaching institute. Our faculty and students investigate questions in science that lie beyond the boundaries of conventional thinking. The whole ambience is very academic with high energy levels to pursue top quality research.

IISER Pune is also a member of the Association of Indian Universities. Since its inception, IISER Pune has published close to 900 research papers in highly reputed national and international journals. Several of these publications have come out of the 5th year research projects of BS-MS students.

More: http://www.iiserpune.ac.in/

Indian Institutes of Science Education and Research (IISER Mohali, Punjab

IISER Mohali started its academic programs in 2007 with a small batch of students in the BS-MS dual degree program. Four batches of students have completed the course requirements and have been awarded their degrees. The PhD program was started in 2008 and most of the students who joined then have graduated. The Integrated PhD program was started in 2012.

IISER Mohali's fully residential campus is coming up on 125 acres of land given by the Punjab Government, in the Knowledge City at Sector 81 Mohali. Most of the buildings in the initial phase have been completed and are in use. With a faculty of 70, various programs for 870 students are being conducted along with cutting edge research in basic sciences.

More: http://www.iisermohali.ac.in/

Indian Institutes of Science Education and Research (IISER), Bhopal, Madhya Pradesh

Indian Institute of Science Education and Research Bhopal will provide a platform for the faculty to engage in high quality pedagogy, at both undergraduate and postgraduate levels, and to perform cutting edge research in frontier areas of basic sciences. The Institute is also committed

to impart high moral and ethical values to students and create a genuine concern for social and environmental issues. IISER Bhopal offer BS-MS (Dual Degree) programme, Integrated Ph.D. programme in Chemistry, Mathemetics and Physics and Ph.D. programme in Biological Sciences, Chemistry, Earth and Environmental Sciences, Mathematics and Physics. The details of these programs can be found under academic affairs.

Vision

- ✓ "To emerge as an Institute of the highest calibre in which teaching and education will be totally integrated with the state of the art research."

Mission

- ✓ Promote research and development activities in science and application of scientific methods by investing in infrastructure and faculty, promoting academic reforms and spreading scientific awareness among public.
- ✓ Provide pivotal training in natural sciences and liberal arts enabling the young minds to develop not only rationale but creative thinking capabilities as well.
- ✓ Foster an environment of liberal education of natural sciences with a spirit of freedom of thought.
- ✓ To collaborate and develop strategic alliances in order to tread new and innovative vistas for long-term dialogue between academia and industry.
- ✓ To nurture a scientific temper in the society so as to eliminate the illogical dogmas and irrational thoughts.
- ✓ Create a cadre of scientists of high calibre imparting training in the latest techniques of scientific experimentation in order to carry out research at the cutting-edge areas of science.
- ✓ To emerge as a hub of research and development activities in science and application of scientific and application of scientific methods.
- ✓ To strengthen the national education and research base in natural sciences, social sciences, engineering sciences and creative arts as well in order to become a powerful stakeholder in global knowledge economy.
- ✓ To ultimately emerge as a center of excellence in creative science education and research.
- ✓ To play a pivotal role by contributing for the growth of our economy through global leadership in science.
- ✓ Contribute to India and the world in the pursuit of achieving Global Excellence in generation of Knowledge and Research based Learning.
- ✓ To provide guarantee of clean hostel, clean mess, clean water and hygienic and wholesome food to its students.

More: https://iiserb.ac.in/index.php

Indian Institutes of Science Education and Research (IISER), Thiruvananthapuram, Kerala

Indian Institute of Science Education and Research, Thiruvananthapuram (IISER-TVM) is dedicated to scientific research and science education of international standards. Traditionally, teaching has been segregated from research in undergraduate science curricula in our country. IISERs were established by the Ministry of Human Resource Development, Government of

India, to bridge this dichotomy. IISER-TVM started functioning in August 2008. The institute aims to provide high quality education in modern science, integrating it with outstanding research at the undergraduate level itself, and develop a spirit of research cutting across disciplines. The faculty are engaged in research in the frontier areas of basic sciences, with a high degree of autonomy and creativity.

More: www.iisertvm.ac.in/

Indian Institutes of Science Education and Research (IISER) IISER Tirupati, Andhra Pradesh

IISER Tirupati is the sixth Institute in the chain of IISERs being established by the Govt. of India under the Ministry of HRD for imparting quality education in basic sciences and set up state-of-art research facilities for front line and cutting edge research in science. This is a new institute and is currently being mentored by IISER Pune.

The Director and the Board of Governors of IISER Pune will be looking after the IISER Tirupati activities till the Director for IISER Tirupati is appointed.Similarly, a separate Board of Governors and other statutory bodies are will be constituted for the new institute.

More: www.iisertirupati.ac.in/

UNIVERSITIES

1. Banaras Hindu University, School of Biotechnology

The School of Biotechnology was established in 1986 with the financial support from the Department of Biotechnology, Govt. of India, New Delhi. At present Institute of Medical Sciences and Institute of Technology, BHU and other Universities & research institutions are actively participating in the school's multidisciplinary teaching programme. M.Sc (Biotechnology) programme at BHU runs on a semester system consisting of four semesters. The School offers courses in Cell Biology & Virology, Biochemistry & Biophysics, Genetics and Molecular Biology, Microbiology, Animal Cell Culture, Plant Tissue Culture, Computer Applications, statistics, Bioinformatics & Bio statistics Engineering, Immunology, Enzymology and Enzyme Technology, Bioprocess Engineering and Technology and Environmental Biotechnology. A research project forms an integral part of the M.Sc. (IVth Semester) curriculum.

The School is currently pursuing research programmes in the following areas:

- Plant Tissue Culture and Plant Biotechnology
- Cellular and Molecular Immunology and Tumor Immunology
- Molecular Microbiology with emphasis on N2 fixation
- Genetics of plant-bacterium association
- Environmental Biotechnology
- Enzymology and Enzyme Technology

More: http://www.bhu.ac.in/science/biotechnology/

2. University of Pune, Department of Biotechnology

The Department of Biotechnology, University of Pune (University with potential for excellence) established in 1994 offers a two year M.Sc. Biotechnology Course fully supported by the Department of Biotechnology(DBT), Government of India. It also offers M.Phil. and Ph.D. programmes in Biotechnology and related areas. This department since its inception emphasizes on appointing and inculcating meritorious faculty in various specialised branches in Biotechnology. This Department is also involved in developing various national programmes in Biotechnology.

These major areas are:

- Cell Molecular Biology,

- Proteomics and Bioremediation,
- Plant Biotechnology.

More: http://www.unipune.ac.in/dept/science/biotechnology/

3. University of Hyderabad, Department of Biotechnology and Bioinformatics

The Department of Biotechnology and Bioinformatics was founded in 2008 with a vision to be recognized as an academic department of international reputation and to offer cutting edge, interdisciplinary and most-sought after courses in Biotechnology and Bioinformatics.

More: http://www.uohyd.ac.in/index.php/academics/2011-10-27-18-38-04/school-of-life-sciences/dept-biotechnology

4. Jamia Millia Islamia University, Department of Biotechnology, New Delhi
Department of Biotechnology, Jamia Millia Islamia was established in the year 2008 in the Faculty of Natural Sciences. The Department offers graduate and masters on semester system pattern and Ph.D. degrees in biotechnology as per recent UGC norms. Prior to it, from the year 2001-2007, courses at the level of Graduate (B.Sc. Biotechnology) and Masters (M.Sc. Biotechnology) were running in the Department of Biosciences of the same university. The Department of Biotechnology is approaching biotech industries not only to collaborate for product oriented research but also for the placement of the students. Innovative and effective teaching methods are also being adopted.

Details: http://jmi.ac.in/biotechnology

5. Punjab university, Department of Biotechnology

The Department came into existence as Centre in 1989. In 1994 after obtaining financial aid from UGC and DBT, Govt. of India, it was upgraded upto the level of full-fledged Department. Since 1996 the faculty has been awarded several research projects by DBT, DST, UGC, CSIR & ICMR and has produced several Ph.Ds. The Department has many MoU/Research Interactions with Imtech (Chd.), CSIO (Chd.), PGI (Chd.), ICGEB (Delhi), IHBT (Palampur), RRL (Jammu), NDRI (Karnal), NBGAR (Karnal) and pharmaceutical industry. The Department first in North India to start B.Sc. (Hons. School) course in Biotechnology.

More: http://biotechnology.puchd.ac.in/index.php

6. Jamia Hamdard University, Department of biotechnology, New Delhi

The Department of Biotechnology was established in 1997. It offers two formal programmes of study; two year post-graduate course leading to M.Sc. in Biotechnology and doctoral research leading to Ph.D degree.
The major R & D activities include cloning and characterization of novel genes linked with tolerance to biotic and abiotic stresses and quality traits of medicinal and crop plants; authentication and standardization of crude components of herbal formulations; nano vehicle assisted gene delivery and expression in medicinal and crop plants. The thrust areas of centre also include improving the quality of medicinal crops through genetic engineering of metabolic pathways; in vivo and in vitro conservation of medicinal plants; proteomics of host-pathogen interactions; development of easy, rapid, sensitive, cost effective method for aflatoxigenic mould detection in the groundnut kernels and soil; and identification and quantification of aflatoxins in the food and feed.

Thematic area

- Phytochemistry and Biochemistry of plant secondary metabolites.
- Impact of environmental stress on secondary plant metabolites.
- Metabolic engineering of secondary plant metabolites.
- In vitro culture and micropropogation of medicinal plants for increasing the production of secondary metabolites.
- Molecular and Proteomic approach in secondary plant metabolite research.
- Molecular markers for conservation of medicinal plants

More: http://jamiahamdard.edu/

7. JNU, School of Biotechnology New Delhi

Jawaharlal Nehru University (JNU), New Delhi was one of the first six Universities in India to initiate a Postgraduate teaching and research programme in the field of Biotechnology in 1985. Since 1985, it was running as the Special Centre for Biotechnology (CBT) under the joint sponsorship of the University Grants Commission (UGC) and the Department of Biotechnology (DBT), Ministry of Science & Technology, Govt. of India. To begin with, it was started to initiate Biotechnology education programme with an impetus to generate a workforce that could turn into a substantially trained pool to meet the country's demands. Considering the growth of Biotechnology at an international level, its applications in general spheres of life and the significant contributions made by the faculty of the Centre for Biotechnology, the Executive Council of JNU resolved to elevate the status of the Special Centre for Biotechnology to that of a School of Biotechnology (SBT) in 2006. Over the years, Biotechnology programme at JNU has established itself as a leading academic programme both from the teaching and research point of view. The faculty of the School is internationally recognized for their contribution to basic and applied aspects of Biotechnology research.

Details: http://www.jnu.ac.in/sbt/

8. Aligarh Muslim University (AMU), Department of Biotechnology

Since the year 1990 the M.Sc. Biotechnology programme is supported by the Department of Biotechnology (DBT), Ministry of Science & Technology. The DBT also supports the Distributed Information Sub-Centre (DISC) attached to the Unit.

The University admits students to the M.Sc. Biotechnology course through an All India Entrance Test. The students are offered courses in various disciplines of modern biology, biotechnology, lab courses, project work and seminar lectures.
The existing infrastructure of the Unit offers facilities for research in the areas of Molecular Biology, Cellular Immunology/Immunochemistry, Membrane Biology/ Biotechnology, Enzyme Engineering, Structure and Function of Macromolecules and Drug Targeting.

More: http://www.amu.ac.in/departmentpage.jsp?did=47

9. Birsa Agricultural University, College of Biotechnology.

College of Biotechnology was established in the year 1999. Over the years, the College has established excellent facilities for research. Tissue Cultured Plantlets Production is a major activity of the College besides Post Graduate Programme in Biotechnology. The College has seven sections: Tissue Culture, Molecular Biology, Bio-chemistry, Microbiology, Embryo Transfer Technology, Fermentation Technology & Bioinformatics.

Details: http://www.bauranchi.org/

10. Anna University, Centre for Biotechnology

The Centre for Biotechnology was established in 1987 in Anna University with a financial support from Department of Biotechnology, Delhi, University Grants Commission, Delhi and Anna University with an objective:

- To provide educational and training facilities in different areas of Biotechnology
- To carry out fundamental research in the frontier areas of Biotechnology and
- To promote research and consultancy activities in the development of various areas of Biotechnology.

More: https://www.annauniv.edu/BiotechCentre/

11. University of Allahabad, Centre for biotechnology

The Centre of Biotechnology was established in 2000 under Institute of Inter Disciplinary Studies (IIDS) of Allahabad University, supported by Department of Biotechnology, Govt. of India, New Delhi. At present centre offer's Masters programme (4 semester) in Biotechnology. For Masters programme students are admitted through all India Combined Entrance Examination conducted by Jawaharlal Nehru University every year. For D. Phil. programme University hold combined research entrance test (CRET) exam twice in a year and also provide a scholarship to the successful candidates.
Centre has well equipped laboratory dedicated for Master students and also has specific research laboratories for Cynobacterial research, Mashroom biotechnology, Protein folding and translational research (Stem cells biology, bacterial metagenomics and Nanotechnology).

More: http://www.allduniv.ac.in/index.php?option=com_k2&view=item&id=92&Itemid=364

12. Bharathidasan University, Department of Industrial Biotechnology, Tiruchirappalli

Department of Biotechnology was established in 1993. Since then, the Department is actively involved in teaching, research, and consultancy. It embraces topics from basic biology to structural biology, from genomics to genetic conservation, from pathogenicity to toxicology, from gene regulation to human growth factors & cell signaling and from environmental biology to animal & plant physiology and stem cell to regenerative medicine.
Considering the wide openings and vast scope of Biotechnology in the international scientific community, recently in the academic year 2012 - 2013 the Dept. of Biotechnology was elevated to the level School of Biotechnology accommodating two Departments of which, Dept. of Industrial Biotechnology is one. The vision of the Department is to expand knowledge in Basic & Applied Science and Engineering & Technology. The Mission is to pursue career pathway in relevant Technology fields applicable to the Industries. Research in this department includes human, animal, plant, microbial, cell and molecular biology. Bioactive potentials, Immunomodulators, Molecular Biology, Immunodiagnostics, and Microbial Biotechnology are the areas in which research is going on in the Department.

More: http://www.bdu.ac.in/schools/biotechnology/industrial_biotechnology/

13. Maharaja Sayaji Rao University, Department of microbiology and Biotechnology

The Microbiology Department was started in 1964, and since 1985-86, it also offers the M.Sc. Biotechnology Course in addition to the master's course in Microbiology. Biotechnology training

programme was started with support from NBTB (DBT) and UGC and continues to be very popular, attracting programme among students from all over the country. The backbone of the department is the intellectual rigor provided by a dedicated faculty and students coming from all across the country.

The Department has a strong base in Microbial technology and the main focus of the program is on Genetics, Molecular Biology, Industrial Microbiology, Immunology and other contemporary areas allied to Microbiology and Biotechnology. Basic training is given in Microbiology, Biochemistry, Genetics, Developmental Biology, Genetic Engineering, Biochemical Engineering and some aspects of Biophysics, Biostatistics, Environmental Biology.

The broad areas of research in which the department is engaged

Molecular Biology and Genetic Engineering
Microbiology
Bioprocess Engineering
Immunology, Biophysics

More: http://www.bcmsu.ac.in/

14. Department of Plant Molecular Biology & Biotechnology, Tamil Nadu Agricultural University

The Centre for Plant Molecular Biology & Biotechnology (CPMB&B) is rechristened from the Centre for Plant Molecular Biology (CPMB) as per the Proc. No.R2/BM.158/VIII-2/2011/2011 dated 1.08.2011. This earmarks the widening of research priorities in the field of plant molecular biology and plant biotechnology at TNAU. Besides, emphasizing new goals and novel insights in the above fields including bioinformatics, CPMB&B is set to prioritize the existing research objectives and to translate the benefits of research for crop improvement. Since the inception of CPMB there have been several research initiatives in major crops with multitude objectives but leading to one broader goal - Crop improvement. Set to achieve the goals, we believed in bringing together scientists from different disciplines such as plant

breeding and genetics, crop physiology, plant pathology, agricultural entomology, microbiology, bioinformatics and chemistry.

More: http://www.tnau.ac.in/cpmb/cpmb/cpmb.htm

15. Department of Biotechnology, University of Kashmir

DBT (Department of Biotechnology, Ministry of Science and Technology, Govt of India) funded establishment has since grown in stature to be recognized as one amongst top ten Biotechnology schools of the country for the quality of the faculty and the Infrastructure.

Department offers a comprehensive M.Sc Biotechnology Programme for 15 students every year, who come through an open competition among the students graduating in diverse areas of biology. The Programme is based on an elaborate curriculum aimed to develop and elaborate on concepts from basics in biotechnology to advanced fields like Signaling Biology, transcription Biology, Neurobiology, and Genetics etc.

More: http://biotechnology.uok.edu.in/

16. Maduari Kamraj University, School of Biotechnology

The Department of Biotechnology at the Indian Institute of Technology Guwahati (IITG) was established in November 2002 to contribute the fascinating and emerging area of biological sciences. It has both undergraduate (B.Tech.) and postgraduate (M.Tech. and Ph.D.) academic programmes. The Department is unique in North-Eastern India, imparting quality education and providing an excellent research environment through its ongoing programmes. It imparts training for students to make them competent, motivated engineers and scientists. The department has 30 faculty members from diverse streams and specializations. The major thrust of the department includes biochemical engineering, tissue engineering, plant biotechnology, nanobiotechnology, computational biology, cancer biology, infectious diseases and proteomics. The department has initiated efforts to establish advanced research laboratories in all the thrust areas. Apart from

fundamental research, the department aims to meet the targeted demands to cater the requirements of biotechnology based industries.

More: http://mkuniversity.org/direct/

17. Cochin University of Science & Technology, Department of Biotechnology

The Department of Biotechnology was established in 1991 under Cochin University of Science & Technology, The mandate of the Department is to train human resources in Biotechnology and to cater to the needs of the nation in harnessing the vast biodiversity and to promote bioindustries, not only in the state of Kerala but also in the country. The research activities of the Department are on areas in Microbiology, Molecular Neurobiology and Cell Biology, Medical Biochemistry, Genetic Engineering and Plant Biotechnology.

More: http://www.cusat.ac.in/

18. Himachal Pradesh University, Department of Biotechnology

Department of Biotechnology at Himachal Pradesh University, Summer Hill, Shimla (Himachal Pradesh) was established in the year 1995 with major funding from state Government and Department of Biotechnology, Ministry of Science & Technology, Govt. of India. The major objective(s) of the department are:

1. Development of trained manpower in Biotechnology.
2. Research & Development activities related to development of Himachal Pradesh.
3. And to promote interaction between Biotechnology based industries and university.

More: http://hpuniv.nic.in/biotech.htm

19. Gulbarga University, Department of Biotechnology, Karnataka

The Dept of Biotechnology of Gulbarga University is the First Dept. has received funding from DBT Government of India, for strengthening M.Sc., Teaching Programme, and Students will be selected on the basis of JNU entrance examinations.

More: http://www.gulbargauniversity.kar.nic.in/FacSciTech/DeptBioTechnology.html

20. University of Mysore, Department of Applied Botany and Biotechnology

Department of Applied Botany and Biotechnology, University of Mysore is approved by UGC. The Department proved its potential as a premier training and research centre by attracting grants from various national funding agencies like UGC, ICAR, DBT, and DST, and international agencies like DANIDA, EEC etc.

More: http://www.uni-mysore.ac.in/

21. Tamil Nadu Agricultural University, Department of Plant Molecular Biology and Biotechnology

Research and education in Biotechnology at TNAU had its genesis through the university plan scheme "Creation of a new department of biotechnological research. Further in 1988 the Department of Biotechnology, Government of India, New Delhi sanctioned the "Postgraduate education and training programme leading to MSc in Agricultural Biotechnology" which gave a national colour to the biotechnology education at TNAU.

More: http://www.tnau.ac.in/

22. West Bengal University of Technology, Department of Biotechnology

The Department of Biotechnology was established in 2003 with a view to develop a centre of excellence for education and research in biotechnology. In so doing, a four-semester AICTE-approved and DBT supported M.Tech. programme in Biotechnology was started with students qualifying in the All India level Combined Biotechnology Entrance Examination (CBEE) conducted by Jawaharlal Nehru University, New Delhi. It is pertinent to mention that WBUT and Annamalai University are the only two centers in the country in M.Tech Biotechnology supported by the Department of Biotechnology, Government of India.
The main focus of the School of Biotechnology & Biological Sciences is education and training of students in various facets of frontier Science. The post B.Sc. integrated Ph.D courses in Molecular Biology, Microbiology and Bioinformatics are the other important courses under this School.

More: http://www.wbut.ac.in/page.php?id=242

23. Thapar University, Department of Biotechnology, Punjab

Department of Biotechnology and Environmental Sciences at Thapar University, was founded as departmental academic unit in the year 2002, with the mission of defining and establishing a new discipline fusing biotechnology with environmental engineering. The goal of this discipline is to

advance fundamental understanding of how biological systems operate and to develop effective biology-based technologies for applications across a wide spectrum of societal needs through research and education. The innovative educational programmes reflect this emphasis on integrating life sciences with a quantitative, systems-oriented engineering analysis and synthesis approach, offering opportunities at the undergraduate level (B Tech) and at the graduate level (M Sc & M Tech) for the doctoral programme (Ph D). Further, the department recently initiated UGC approved advanced post-graduate diploma in Plant Transgenic Technologies (PGD) for post-graduates in life sciences as well as engineering graduates in biotechnology or applied biology.

More: http://www.thapar.edu/

24. Bangalore University, Department of Microbiology and Biotechnology

The M.Sc Course in Microbiology was introduced in Bangalore University in 1992, while the Department of Studies in Microbiology with an independent status was established in 1997. Since then, the Department has steadily grown. The department has initiated M.Phil and Ph.D programmes. Thereafter in 1998, the department received grants from the UGC to start M.Sc course in Biotechnology. Being the frontier field in science, the department spared no efforts to offer education and training in the field of Biotechnology in the best possible way. Currently the department is offering the M.Sc and Ph.D courses in both Microbiology and Biotechnology and is also coordinating the M.Sc course in Microbiology and Biotechnology being offered in about 64 affiliated colleges of Bangalore University.

More: http://bangaloreuniversity.ac.in/

25. Assam Agricultural University, Jorhat, Department of Biotechnology

A Post-graduate Degree Programme in Agricultural Biotechnology, funded by the Department of biotechnology (DBT), Govt. of India, started functioning since February 1989.
Area of specialization

Broad : Agricultural Biotechnology
Specific : Plant Tissue Culture, Microbial Biotechnology, Plant Molecular Biology

Thrust area
Information Dissemination in Biotechnology

More: http://www.aau.ac.in/

26. Gujarat Agricultural University, Department of Agricultural Biotechnology, Gujarat

The department of Agricultural Biotechnology (- A Center of Excellence in Biotechnology) was established in the year 2002 during ninth five year plan under the erstwhile Gujarat Agricultural University (GAU) at Anand. .

- Center of Excellence on Agricultural Biotechnology and
- Establishment of new department of Genetic Engineering and Biotechnology.

The plant biotechnology, research is focused on:

- Genetic improvement through biotechnological interventions in: Cumin, isabgul, bajra, rice, cotton, durum wheat, pigeon pea & chick pea for :
    - Crop specific Biotic stresses
    - Abiotic stresses and
    - Quality traits
- The plant tissue culture component of research, is focused on :
    - Development of micropropagation protocols in crops of regional importance
    - Exploitation of various in vitro techniques for genetic improvement of crops viz., cumin, rice, etc and
    - Development of regeneration protocols in different crops to support the transgenic development programs.

More: http://www.aau.in/college-menu/572/211

27. Kalasalingam University, Department of Biotechnology, Tamil Nadu

Department of Biotechnology, Kalasalingam University is the Department under Kalasalingam University. The Department offers Bachelor of Technology in Biotechnology, Chemical Engineering, Food Technology, Master of Technology in Biotechnology, Pharmaceutical Biotechnology and Doctor of Philosophy course.

More: http://kalasalingam.ac.in/site/