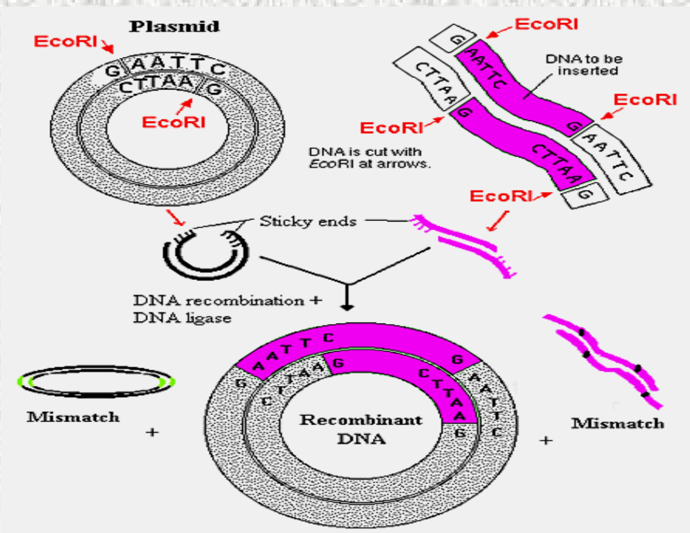
ENVIS CENTRE
ON ENVIRONMENTAL BIOTECHNOLOGY

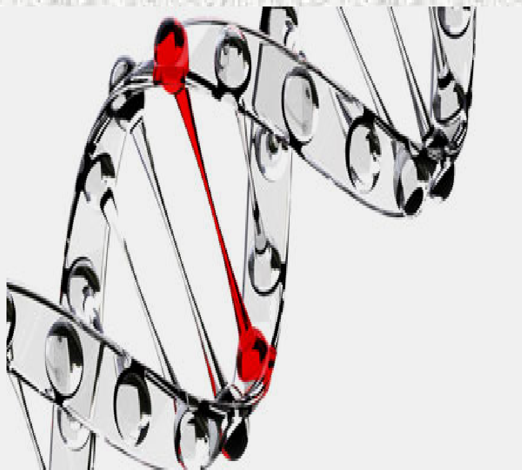
SUPPORTED BY
MINISTRY OF ENVIRONMENT AND FOREST
GOVERNMENT OF INDIA

VOLUME-16 ISSN: 09742476 JUNE, 2010

NEWS LETTER

GENETICALLY MODIFIED ORGANISMS (GMO): ARE THEY HEALTHY FOR THE ENVIRONMENT?





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ENVIS Newsletter on Environmental Biotechnology is a half-yearly publication publishes articles related to the thematic area of the ENVIS Centre. Popular or easily intelligible expositions of new or recent developments are welcome
Manuscripts should be typewritten (font should be Times New Roman and font size ought to be 12) on one side of the paper in double spacing with maximum of 6-8 typed pages
Figures and typed table should be in separate pages and provided with title and serial numbers. The exact position for the placement of the figures and tables should be marked in the manuscript.

Articles should be sent to

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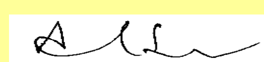
EDITORIAL

GMOs are just one product of the rapidly growing field of biotechnology. New techniques have been developed that make it easier for plant breeders to monitor the outcomes of conventional crossing and selection; allow useful genes to be identified and cloned; and make it possible for genes from the same species to be utilized more quickly and precisely than do the methods of traditional plant breeding. GMOs incorporate genes from another plant species, an animal, a bacterium, or a virus. GMOs are one product of a remarkable expansion in agricultural biotechnology. They offer the possibility of addressing some difficult problems but they also present a number of uncertainties. Their development has sparked debates about the direction of agriculture and the control of technology.

The most pressing need is for good information. These are complex issues that cannot be debated using formulae, slogans or slick advertising. The majority of the reporting and analysis on both sides of the GMO issue has not been accompanied by adequate technical information. Thus, in Volume-16, we have emphasized on the genetically modified organisms and major issues and controversies related to this technology. Further we appreciate the views of the reader /user groups about this newsletter.We also invite relevant articles, news, events on this topic for publication in newsletter in future



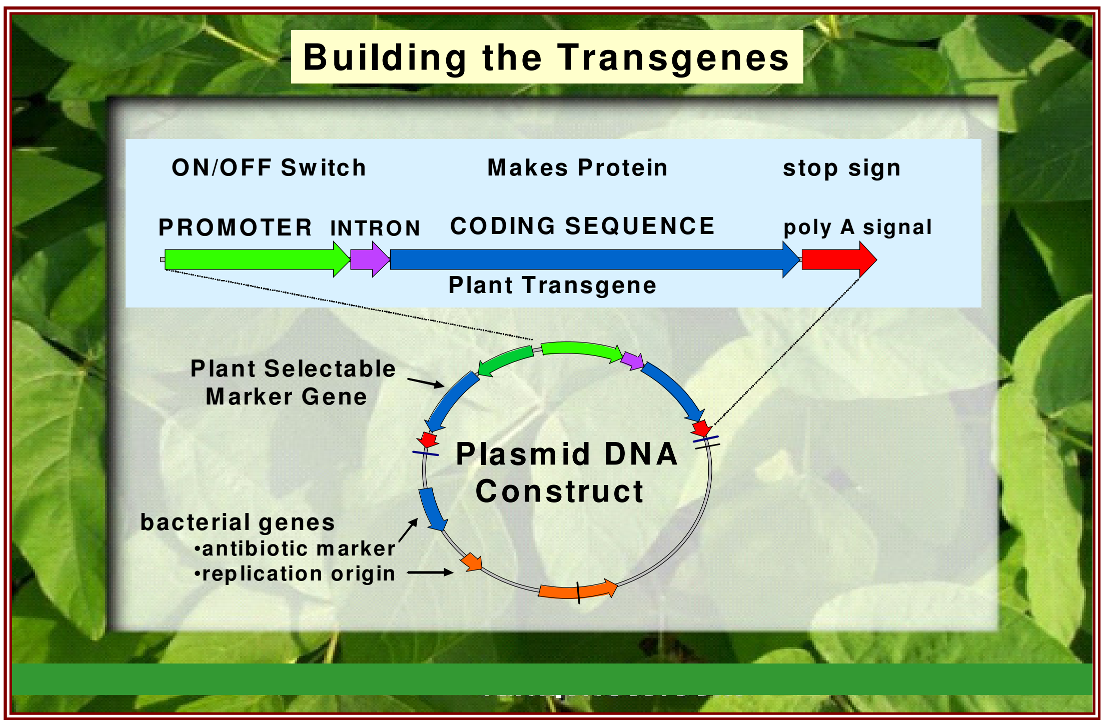
(S.C.Santra)

IN THIS ISSUE:

GENETICALLY MODIFIED ORGANISMS (GMO) ARE THEY HEALTHY FOR THE ENVIRONMENT?

WHAT ARE GMOS?

A genetically modified organism (GMO) or genetically engineered organism (GEO) is an organism whose genetic material has been altered using genetic engineering techniques. These techniques, generally known as recombinant DNA technology, use DNA molecules from different sources, which are combined into one molecule to create a new set of genes. This DNA is then transferred into an organism, giving it modified or novel genes. Transgenic organisms, a subset of GMOs, are organisms which have inserted DNA that originated in a different species.



HISTORY OF GMO

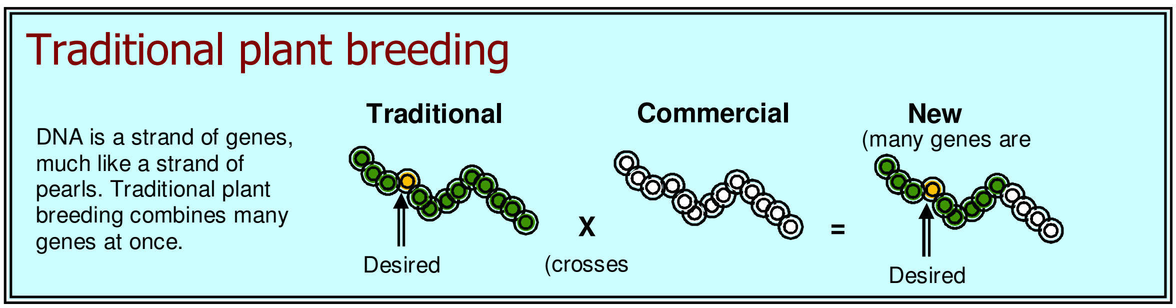
Genetic engineering was made possible through a series of scientific advances including the discovery of DNA and the creation of the first recombinant bacteria in 1973, i.e., *Escherichia .coli* expressing a Salmonella gene. This led to concerns in the scientific community about potential risks from genetic engineering which has been thoroughly discussed at the Asilomar Conference in

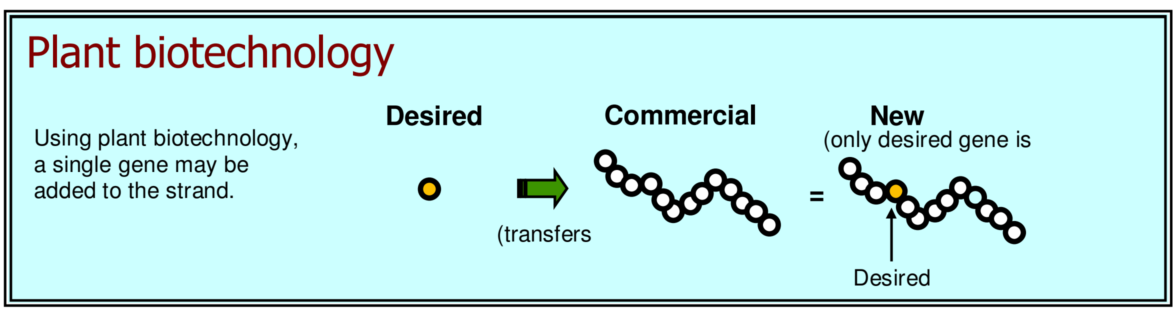
Pacific Grove, California. Herbert Boyer'company, Genentech, in 1978 announced the creation of an E. coli strain producing the human protein insulin.

In 1986, field tests of bacteria genetically engineered to protect plants from frost damage (ice-minus bacteria) at a small biotechnology company called Advanced Genetic Sciences of Oakland, California, were repeatedly delayed by opponents of biotechnology. There onwards started the advent of genetically engineered microbes.

GM VS. MENDEL'S SELECTIVE BREEDING

Selective breeding	GM
Slow	Very fast
Imprecise	Precise
Modification of genes that naturally occur in the organism	Can introduce genes into an organism that would not occur naturally





APPLICATION OF GMO

GMOs have widespread applications. Genetically modified microbes can be used for the following applications:

1. **Bioremediation**
2. **Industry**
3. **Agriculture**

1. Bioremediation Using Genetically Engineered Microbes

Bioremediation of environmental contaminants using genetically engineered organisms (GEMs) holds tremendous potential.

- **Genetically engineered microorganism (GEM) for detecting PAHs in the soil**

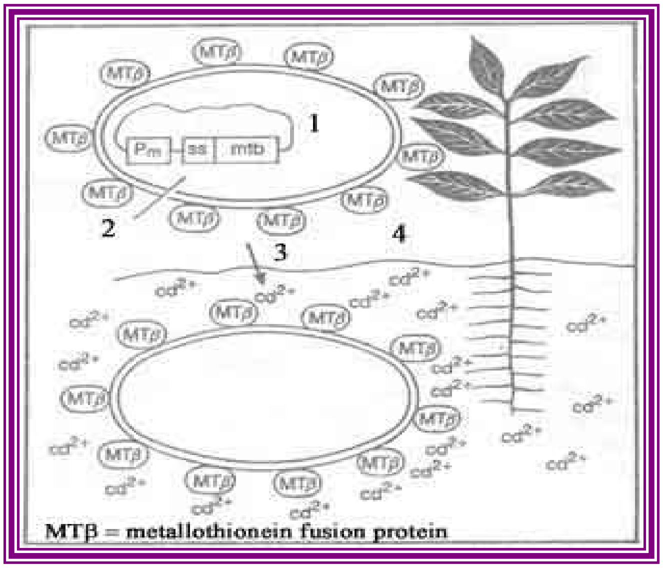
One of the areas, where genetically engineered organisms have been used and are likely to be used include biodegradation of polyaromatic hydrocarbons (PAHs) in soil. These PAHs include naphthalene, phenanthrene, and anthracene, whose occurrence in the soil is due to spills or leakage of fossil fuels or petroleum products. In USA, *Pseudomonas fluorescens* isolated from PAH contaminated soils, was genetically engineered with lux genes from *Vibrio fischeri*, a bacterium that lives in the light generating organisms of certain deep sea fish. The lux gene was fused with a promoter normally associated with the naphthalene degradation pathway. These lux genes do not need any independent substrate for light production. The modified strain, *P. fluorescens* HK44 responds to napththalene by luminescence, which can be detected with the help of light sensing probes. This will allow the detection of PAHs in the contaminated soils, so that the biodegradations can now be optimized by altering moisture content and level of different gases in the soil.

- **Genetically engineered microorganism for treating oil-spills**

The first genetically engineered organism for bioremediation was actually produced by Dr. Ananda Mohan Chakrabarty in USA. This GEM was a Pseudomonas, which was capable of degrading 2,4,5-trichlorophenoxyacetic acid (2,4,5-T). the strain contained two plasmids, each providing a separate hydrogen degradative pathway, and therefore was claimed to be effective in treating oil spills. Several other microbes have been developed through genetic engineering for treatment of oil spills.

- **Genetically engineered microorganism for sequestering of heavy metals**

A new approach for bioremediation that was suggested recently, involved engineering of microorganisms to enhance their ability of sequester heavy metals in the soil. In this approach, the toxic metal within the soil remains bound to the GEM, so that it is less likely to be taken up either by the underground part (roots) of the terrestrial plants, or by other plants or animals living in the soil. The enhanced ability to sequester heavy metals (e.g. cadmium) was achieved by transfer of a mouse gene, encoding metallothionein of a *Ralstonia eutropha* (a natural inhabitant of soil). Metallothionein in this GEM was expressed on the outer surface of the cells to help in sequestering of cadmium.



1.	synthesis and export of MTβ	**2.**	genetically engineered Ralstonia eutropha soil
3.	inoculation	**4.**	cd-sensitive plant

Engineering of Soil Bacterium for Enhanced Sequestration of Toxic Metals. MTβ = metallothionein

Issues involve in application of GMO in bioremediation

Many issues remain to be resolved before this method is adopted widely. Priority areas of research include the following:

- ✓ Improving microbial strains;
- ✓ Improving bioanalytical methods for measuring the level of contaminants
- ✓ Developing analytical techniques for better understanding, control and optimization of environmental and reactor systems

2. Using Genetically Engineered Microbes in Industry

In recent years, micro organisms have found their application not only in the production of a variety of metabolites but also in the bio- transformation of several chemicals. The genetically engineered micro organisms are also being used for the commercial production of some non microbial products such as **insulin, interferon, human growth hormone and viral vaccines.** Microbes are also being used to meet effectively the crisis in both environment and energy sectors. They can reduce environmental pollution through a variety of processes and other means including the following:

(i) Recovery of metals from polluted waterways-

(ii) Elimination of sulphur from metal ores and coal fired power and

(iii) Use of biofertilizers and biopesticides

(iv) In the energy sector, they can be used for production of single cell proteins (SCP) to meet food and fodder problems, and for biogas production to provide energy to electrify villages.

3. Using Genetically Engineered Microbes in Agriculture

To date the broadest and most controversial application of GMO technology is in agriculture especially in patent-protected food crops which are resistant to commercial herbicides or are able to produce pesticidal proteins from within the plant, or *stacked trait* seeds, which do both. The largest share of the GMO crops planted globally is owned by the US firm Monsanto.

Different application of GMO in production of crops which resist different types of viral, bacterial and insect pest :

- Potato - modified to produce a beetle killing toxin
- Yellow squash – modified to contain viral genes that resistant to the most common viral diseases
- Develop foods that contain vaccines and antibodies that offer valuable protection against diseases such as cholera, hepatitis, and malaria
- Canola – modified to resist one type of herbicide or pesticide

Some Approved Agricultural Biotech Products

Canola
LibertyLink® Canola
InVigor® Hybrid Canola
Roundup Ready® Canola

Corn
Attribute™ Bt Sweet Corn
CLEARFIELD Corn®
DeKalBtTM Insect-Protected Hybrid
DeKalb Brand Roundup Ready®
Gray Leaf Spot -Resistant Corn Hybrids
StarLink Corn
YieldGardTM Insect-Protected Corn

Soybeans
High Oleic Acid Soybeans
Low Linolenic Soybean Oil
Low Saturate Soybean Oils

Peanuts
High Oleic Peanuts

Papaya
Rainbow and SunUp

Cotton
Bollgard® Insect-Protected Cotton
Roundup® Ready Cotton

Milk Production
Chymogen®
Posilac® Recombinant Bovine Somatotropin
ChyMax®

Potatoes
NewLeaf® Insect-Protected Potato
NewLeaf® Plus
New-Leaf® Y Insect- and Virus-Protected Potatoes

Tomatoes
FreshWorld Farms® Tomato
FreshWorld Farms Endless Summer®
FreshWorld Farms® Cherry

Sunflowers
High Oleic Sunflower
High Oleic Sunflower Oil

WHAT ARE THE DANGERS OF USING GMO TECHNOLOGY?

Following issues are of great concern regarding GMO

1. Fundamental weaknesses of the concept
2. Health hazard and environmental hazard and related food safety
3. Increased corporate control of agriculture and unintended economic consequences

1 Fundamental Weaknesses of the Concept

Imprecise Technology—A gene can be cut precisely from the DNA of an organism, but the insertion into the DNA of the target organism is basically random. As a consequence, there is a risk that it may disrupt the functioning of other genes essential to the life of that organism. (Bergelson 1998)

Side Effects—Genetic engineering is like performing heart surgery with a shovel. Scientists do not yet understand living systems completely enough to perform DNA surgery without creating mutations which could be harmful to the environment and our health. They are experimenting with very delicate, yet powerful forces of nature, without full knowledge of the repercussions. (Washington Times 1997, The Village Voice 1998)

Widespread Crop Failure—Genetic engineers intend to profit by patenting genetically engineered seeds. This means that, when a farmer plants genetically engineered seeds, all the seeds have identical genetic structure. As a result, if a fungus, a virus, or a pest develops which can attack this particular crop, there could be widespread crop failure. (Robinson 1996)

Threatens Our Entire Food Supply—Insects, birds, and wind can carry genetically altered seeds into neighboring fields and beyond. Pollen from transgenic plants can cross-pollinate with genetically natural crops and wild relatives. All crops, organic and non-organic, are vulnerable to contamination from cross-pollinatation. (Emberlin et al 1999)

2. Health and environmental hazard and related food safety

Health Hazards

No Long-Term Safety Testing—Genetic engineering uses material from organisms that have never been part of the human food supply to change the fundamental nature of the food we eat. Without long-term testing no one knows if these foods are safe.

Toxins—Genetic engineering can cause unexpected mutations in an organism, which can create new andhigher levels of toxins in foods. (Inose 1995, Mayeno 1994)

Allergic Reactions—Genetic engineering can also produce unforeseen and unknown allergens in foods. (Nordlee 1996)

Decreased Nutritional Value—Transgenic foods may mislead consumers with counterfeit freshness. A luscious-looking, bright red genetically engineered tomato could be several weeks old and of little nutritional worth.

Antibiotic Resistant Bacteria—Genetic engineers use antibiotic-resistance genes to mark genetically engineered cells. This means that genetically engineered crops contain genes which confer resistance to antibiotics. These genes may be picked up by bacteria which may infect us. (New Scientist 1999)

Problems Cannot Be Traced—Without labels, our public health agencies are powerless to trace problems of any kind back to their source. The potential for tragedy is staggering.

Can Side Effects Kill Human Beings?- 37 people died, 1500 were partially paralyzed, and 5000 more were temporarily disabled by a syndrome that was finally linked to tryptophan made by genetically-engineered bacteria. (Mayeno 1994)

Environmental Hazards

Increased use of Herbicides—Scientists estimate that plants genetically engineered to be herbicide-resistant will greatly increase the amount of herbicide use. (Benbrook 1999) Farmers, knowing that their crops can tolerate the herbicides, will use them more liberally.

More Pesticides—GE crops often manufacture their own pesticides and may be classified as pesticides by the EPA. This strategy will put more pesticides into our food and fields than ever before.

Ecology may be damaged—The influence of a genetically engineered organism on the food chain may damage the local ecology. The new organism may compete successfully with wild relatives, causing unforeseen changes in the environment. (Metz 1997)

Gene Pollution cannot be cleaned Up—Once genetically engineered organisms, bacteria and viruses are released into the environment it is impossible to control or recall them. Unlike chemical or nuclear contamination, negative effects are irreversible.

3. Increased corporate control of agriculture and unintended economic consequences

Another concern associated with GMOs is that private companies will claim ownership of the organisms they create and not share them at a reasonable cost with the public. Use of genetically modified crops will hurt the economy and environment, because monoculture dominates over the diversity contributed by small farmers who can't afford the technology.

POSSIBLE BENEFITS OF GM FOODS

Easing of world hunger

Development of crops that can be grown in marginal soil

Reduced strain on nonrenewable resources

- Development of drought resistant crops.
- Development of salt-tolerant crops.
- Development of crops that make more efficient use of nitrogen and other nutrients.

Reduced use of pesticides and herbicides

- Development of pest resistant crops.
- Reduced herbicide use is better for the environment and reduces costs for farmers.

Improved crop quality

- Development of frost resistant crops.
- Development of disease resistant crops.
- Development of flood resistant crops.

Improved nutritional quality

Development of foods designed to meet specific nutritional goals

MAIN CONTROVERSIES ARISES REGARDING GMOS

Safety

- Potential human health impacts, including allergens, transfer of antibiotic resistance markers, unknown effects
- Potential environmental impacts, including: unintended transfer of transgenes through cross-pollination, unknown effects on other organisms (e.g., soil microbes), and loss of flora and fauna biodiversity

Access and Intellectual Property

- Domination of world food production by a few companies
- Increasing dependence on industrialized nations by developing countries
- Biopiracy, or foreign exploitation of natural resources

Ethics

- Violation of natural organisms' intrinsic values
- Tampering with nature by mixing genes among species
- Objections to consuming animal genes in plants and vice versa
- Stress for animal

Labeling

- Not mandatory in some countries (e.g., United States)
- Mixing GM crops with non-GM products confounds labeling attempts

Society

New advances may be skewed to interests of rich countries.

ACT AND REGULATIONS ON GENETICALLY MODIFIED ORGANISMS IN INDIA

In India, the Genetically Modified Organisms are regulated under the *Environment Protection Act 1986* (EPA).

In addition the Indian biosafety regulatory framework comprises:

- Rules for the “Manufacture, Use, Import, Export and Storage of Hazardous Microorganisms, genetically Modified Organisms and Cells" (1989 Rules),
- Department of Biotechnology guidelines, the 1990 "Recombinant DNA Safety Guidelines" (1990 DBT Guidelines)

- Revised Guidelines for "Safety in Biotechnology" (1994 DBT Guidelines)
- Revised Guidelines for "Research in Transgenic Plants and Guidelines for Toxicity and Allergenicity Evaluation of Transgenic Seeds, Plants and Plant Parts" (1998 DBT Guidelines).
- Seed Policy, 2002

Objectives of regulations

- The objective of EPA is protection and improvement of the environment. The Act calls for the regulation of Environment Pollutants, defined as any solid, liquid or gaseous substance, present in such concentration that tend to be injurious to the environment.
- The 1990 and 1994 DBT guidelines recommend appropriate practices, equipments and facilities necessary for safeguards in handling GMOs in agriculture and pharmaceutical sectors. These guidelines cover the R&D activities 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 1998 DBT guidelines cover areas of recombinant DNA research on plants including the development of transgenic plants and their growth in soil for molecular and field evolution. It also calls for the toxicity and allergenicity data for ruminants such as goats and cows, from consumption of transgenic plants. It also requires the generation of data on comparative economic benefits of a modified plant.

The regulations classify activities involving GMOs into four risk categories

- **Category I** comprises *routine* recombinant DNA experiments conducted inside a laboratory;
- **Category II** consists of both laboratory and greenhouse experiments involving transgenes that combat biotic stresses through resistance to herbicides and pesticides;
- **Categories III** and IV comprise experiments and field trials where the escape of transgenic traits into the open environment could cause significant alterations in the ecosystem.

The regulatory framework for GMO in India

The two main agencies responsible for implementation of the rules are the Ministry of Environment and Forests (MoEF) and the Department of Biotechnology (DBT), Government of India. The rules have also defined competent authorities and the composition of such authorities for handling of various aspects of the rules.
There are six competent authorities as per the rules:

1. **Recombinant DNA Advisory Committee (RDAC)**
2. **Review Committee on Genetic Manipulation (RCGM)**
3. **Genetic Engineering Approval Committee (GEAC)**
4. **Institutional Biosafety Committees (IBSC)**
5. **State Biosafety Coordination Committees (SBCC)**

6. **District Level Committees (DLC).**

Out of these, the three agencies that are involved in approval of new transgenic crops are:

- IBSC set-up at each institution for monitoring institute level research in genetically modified organisms.
- RCGM functioning in the DBT to monitor ongoing research activities in GMOs and small scale field trials.
- GEAC functioning in the MoEF to authorize large-scale trials and environmental release of GMOs.

Cartagena Biosafety Protocol

The Cartagena Protocol on Biosafety, the first international regulatory framework for safe transfer, handling and use of living Modified Organisms (LMOs) was negotiated under the aegis of the Convention on Biological Diversity (CBD). The Protocol was adopted on 29th January, 2000. One hundred and forty three countries have signed the Protocol. India has acceded to the Biosafety Protocol on 17th January 2003. The Protocol has come into force on 11th September, 2003. As of date, 143 countries are parties to the Protocol.

Some Useful links regarding the details of biosafety regulations

http://www.envfor.nic.in/divisions/csurv/geac/geac_home.html
http://dbtbiosafety.nic.in
http://www.igmoris.nic.in

CURRENT NEWS EVENTS

Researchers Synchronize Blinking 'Genetic Clocks' -- Genetically Engineered Bacteria That Keep Track of Time

Researchers at UC San Diego who last year created genetically engineered bacteria to keep track of time by turning on and off fluorescent proteins within their cells have taken another step toward the construction of a programmable genetic sensor. The scientists recently synchronized these bacterial "genetic clocks" to blink in unison and engineered the bacterial genes to alter their blinking rates when environmental conditions change. Their latest achievement is a crucial step in creating genetic sensors that might one day provide humans with advance information about temperature, poisons and other potential hazards in the environment by monitoring changes in the bacterium's blinking rates. "Programming living cells is one defining goal of the new field of synthetic biology according to Jeff Hasty, associate professor of biology and bioengineering at UCSD who headed the research team with Lev Tsimring, associate director of UCSD's BioCircuits Institute.Synchronization of clocks and oscillators in general has been a fascinating subject for physicists and applied mathematicians for centuries. This began with the Dutch mathematician and astronomer Christiaan Huygens, who is credited with its serendipitous discovery in 1665 when he suspended a pair of nearly identical pendulum clocks (which he invented and patented some 8 years earlier) on the same wooden beam. This phenomenon has a myriad of applications in modern technology, from communication networks to GPS. This study demonstrates how inherently noisy gene oscillators can operate together with beautiful synchronicity and regularity once coupled together in a specific way.

Over the past decade, researchers have gone from wiring genetic toggle switches and oscillators in living cells to building living circuits capable of pattern generation, noise shaping, edge detection and event counting. In their latest development, the UCSD researchers took advantage of a type of bacterial communication in which bacteria exchange small molecules. Many bacterial species are known to communicate by a mechanism known as quorum sensing, that is, relaying between them small molecules to trigger various behaviors. Other bacteria are known to disrupt this communication mechanism by degrading these relay molecules.

The researchers constructed devices to precisely control the sizes of the bacterial colonies between two different scales: a micron, or a millionth of a meter, and a millimeter, or one-thousandth of a meter.
(Source: *Science Daily , Jan. 24, 2010)*

Anomalous accumulation of selenium by genetically modified potato, stable to Colorado beetle

Potatoes are the fourth largest crop grown in the world, exceeded only by wheat, rice and corn. The major limiting factor in growing potatoes in many areas of the world, including Russia, is the Colorado potato beetle (*Leptinotarsa decemlineata* Say) (CPB), which is resistant to most classes of chemical pesticide. A prospective solution to this problem is to use a protein (Cry 3A protein) toxic to CPB, produced by a naturally occurring soil bacterium, *Bacillus thuringiensis* (Bt). The mechanism of Cry 3A protein on CPB does not differ from that of other Bt Cry proteins, known to possess high selectivity for different pests. The primary action of Cry toxins is to lyse midgut epithelial cells in the target insect by forming pores in the apical microvilli membrane of the cells leading to severe septicemia and insect death. The benefits of using such Bt-plants include increased crop yields, reduced pesticide use, less environmental damage and reduced labor. CPB-resistant potatoes were first developed and sold in the USA in 1994 under the NewLeaf trademark to control CPB. Although there is no commercial production of Bt-potatoes in Russia, the Russian Center of Bioengineering has adapted the technology developed by Monsanto (St Louis, MO), one of the world's biggest biotechnology companies, for three varieties of potatoes commonly grown in Russia.

General property of Bt-plants is an elevated level of lignin. This peculiarity is poorly expressed in CPB-resistant potatoes, where not only lignin, but also starch, carbon and nitrogen concentrations are close to those of non-modified plants. The lack of information on the selenium (Se) content in Bt-crops has prompted Russian investigation on the Se status in CPB-resistant potatoes, as this element is implicated in the protection mechanism of plants against insect attack.

Using a fluorimetric method of analysis, Russian investigators have demonstrated extremely high Se accumulation in leaves of CPB-resistant potatoes (more than 1 mg kg^{-1} dry weight) and moderate accumulation levels of Se in tubers (1.39 times more than in ordinary plants). Leaves of genetically modified potatoes are shown to possess a decreased concentration of ascorbic acid (1.5 times less than controls) and slightly elevated levels of nitrates. The possibility of Se participation in the protection of genetically modified potatoes against CPB is discussed in their research paper.

(Source: Journal of Food Composition and Analysis, Volume 23, Issue 2, March 2010, Pages 190-193)

A novel biosensor based on genetically modified *Saccharomyces cerevisiae* strain for the detection of zearalenone family mycotoxins in milk

Scientists of Finland developed a method for detecting estrogenic mycotoxin residues in milk was developed utilizing bioluminescent whole-cell biosensors. Milk products of various compositions were spiked with the estrogenic mycotoxins zearalenone and its metabolites zearalanone, α-zearalanol, β-zearalanol, α-zearalenol and β-zearalenol. The estrogenic response was detected by a whole-cell biosensor based on a genetically modified *Saccharomyces cerevisiae* strain that in the presence of an estrogenic compound produces firefly luciferase-enzyme and further light emission within a system provided with D-luciferin substrate. The results show that the yeast sensor reacts to mycotoxins with typical sigmoidal response at nanomolar concentrations. The response differs in different milk products with regard to the fat content of the milk. Due to short assay time of less than 3 h and automation the approach can be used as a bioavailability and activity screening method prior to more detailed chemical analysis.

(Source: Journal of Microbiological Methods, Volume 80, Issue 1, January 2010, Pages 44-48)

Towards a super H_2 producer: Improvements in photofermentative biohydrogen production by genetic manipulations

The fossil fuels are limited and being consumed rapidly. Therefore, new alternative energy sources are to be investigated. Hydrogen as an energy carrier could be produced from renewable and sustainable energy sources and it could safely be used due to following reasons. Today, although the hydrogen gas was mostly produced through the non-biological means (chemical ways) such as steam reforming, biological hydrogen production methods are still being investigated and being improved. Hydrogen, the candidate for the worldwide future alternative energy carrier, can be produced through photofermentation by photosynthetic bacteria, such as *Rhodobacter sphaeroides*, *Rhodobacter capsulatus*, *Rhodospirullum rubrum* and *Rhodopseudomonas palustris.*

Photofermentative hydrogen production by purple non-sulfur bacteria is a potential candidate among biological hydrogen production methods. Hydrogen is produced under anaerobic conditions in light using different organic substrates as carbon source. The hydrogen evolution occurs mainly through the catalytic activity of the nitrogenases under non-repressive concentrations of ammonia. However, total hydrogen production is constrained due to several reasons in purple non-sulfur (PNS) bacteria, such as consumption of hydrogen by uptake of hydrogenase, inefficient hydrogen production capacity of nitrogenase, limited electron flow to the nitrogenase, sensitivity of nitrogenase towards ammonia, etc. Hence, PNS bacteria need to be manipulated genetically to overcome these limitations and to make the process practically feasible. In this article scientists of Turkey focuses on various approaches for the genetic improvement of biohydrogen production by PNS bacteria.

(Source: International Journal of Hydrogen Energy, 2010,Article in Press)

Brazil: greater sugarcane yield through gene technology

In the next years, genetically modified (GM) sugarcane is expected to enter the Brazilian market and to deliver a sugar content that has been increased by 30 to 40 per cent. Bayer CropScience and the Brazilian research institution CTC have agreed upon "comprehensive cooperation" towards this goal.

The aim of the cooperation between the agro-firm, based in Germany, with the leading Brazilian research institute for sugarcane, CTC (Centro de Tecnologia Canavieira), is the development of new varieties with significantly enhanced sugar content.

Sugarcane is the plant from which the highest exploitation of bio-fuel may be realised. In order to compete with fossil fuels on the world market, the Brazilian government intends to increase sugarcane farming further in the next years and to make the production of bio-ethanol more effective.

Today, Brazil already is the site of almost one half of sugarcane production world-wide. Commercially available fuels in the country contain a bio-ethanol admixture of between 20 and 25 per cent.

With regard to the cooperation, the CTC institute can provide a great deal of experience in the breeding and processing of sugarcane, while Bayer CropScience has announced that the company primarily will provide access to "gene technologies". The common goal is the development of new varieties with higher sugar content. According to press information from Bayer CropScience, early research results indicate a rise of 30 to 40 per cent. Approval applications for the first commercial products are expected as early as 2015.

CTC executive director Nelson Boeta states, "We predict a great increase in yield through the combination of our sugarcane varieties with the technology from Bayer. Sugarcane is the most competitively capable plant to date with regard to winning renewable energy and this cooperation with Bayer will continue to increase competitive capacity."

(Source: GMO compass: www. gmo-compass.org, 29th May 2010)

FORTHCOMING EVENTS

11th International Symposium on the Biosafety of Genetically Modified Organisms (ISBGMO)	**Novemer, 20, 2010**	**Buenos Aires, Argentina** **Web:http://www.is/bgmo.info** **Email: isbgmo@isbr.info**
GMO-FREE EUROPE 2010, 6th European Conference of GMO-Free Regions	**September, 16-18 2010**	**Brussels and Ghent** **Web: www.gmo-free-regions.org/** **Email: info@gmo-free-regions.org**
Symposium HortGen: Genetically Modified Horticultural Crops, from the lab to the field (xxviii international horticultural congress – IHC 2010)	**August 22-27, 2010**	**Lisbon ,Portugal** **E-mail symposium: info@ihc2010.org**
ISHS Genetically Modified Organisms in Horticulture Symposium: Paving the way for a Sustainable Future	**September 12-16, 2011**	**Nelspruit , South Africa** **E-mail: adri.veale@up.ac.za** **Web:http://www.gmo2011.co.za/**

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