المنظمة الإسلامية للتربية والعلوم والثقافة

ISESCO إيسيسكو

Strategy for the Development of Biotechnology in the Islamic World

Islamic Educational, Scientific and Cultural Organization

-ISESCO-

CONTENTS

STRATEGY FOR DEVELOPMENT OF BIOTECHNOLOGY IN THE ISLAMIC COUNTRIES

1. Vision

To enable the Islamic world to achieve self sufficiency in the development and use of biotechnology in all fields and to contribute to the development of the Islamic world.

2. Introduction and Background

Biotechnology has been frequently referred as the technology of 21st century along with Information Technology. This has been mainly due to the developments in life sciences during the last three decades of the last century which saw the concurrent developments of a number of novel and new techniques in biological sciences that not only advanced research tremendously but also carried with them the promise of improvement in life standards of mankind. Recombinant DNA techniques, or genetic engineering, received most publicity in this period since there was a tremendous excitement about impetus which was likely to be given to research and ultimately demonstrated by the enhanced industrial potential. Equally important to the potential of the recombinant DNA techniques was the discovery of other inventions or laboratory manipulations like sequence determination of genes, plant cell culture, formation of embryos of animals with cells from more than two donors; mixed or hybrid, animal cells with the production of one type of antibodies, and other processes like immobilization of cells or enzymes to insoluble materials for enhancement of stability and recovery. Similarly studies pertaining to animal physiology and cell biology revealed possibilities unlimited for employing complex biological materials to be used in diagnosis and therapy in human medicine following the lead of insulin treatment for diabetes.

Biotechnology not only contributed by developing biological processes complementary to chemical technologies but also provided economical, efficient, clean, pollution-free biological technologies. The production of sophisticated biochemicals including drugs, diagnostics and bacterial leaching of metals from ores by these biotechnological industries has not only replaced the inefficient, resource consuming, and often pollution producing chemical technologies, but also have exerted an environmental impact by slowing down the depletion of valuable non-renewable resources.

Biotechnology can be defined as industrial processes based on biological systems involving naturally-occurring micro organisms, micro organisms that have been modified by genetic engineering or isolated cells of plants or animals and the genetic manipulation of cells to produce new strains of plants or animals. Hence use of various biological processes to make products and perform services can be considered encompassed by Biotechnology: and its essential components, therefore, are biological processes which are based on living cells and biochemical molecules like proteins, DNA, RNA, thus making a practical use of the recent scientific advances in areas like molecular genetics.

The 1920s and 1930s saw the birth of petrochemical industry brought about by the creative union of chemical engineers with organic chemists. The 1980s and 1990s have witnessed a biochemical industry, born from a new creative union of biochemical engineers

and molecular biologists. Learning fundamental properties and mechanisms on an ongoing basis is absolutely essential for long-term professional viability in a technically vibrant area such as biotechnology. However, this is not a new technology. Alcohol fermentations and bread making have been carried out since pre-historic times, thereby employing microbes for the benefit of mankind.

Since 1975, genetic engineering component has initiated a profound revolution in science with enormous technological and social consequences. This laid the foundations of New or Modern Biotechnology. This last era, is neither constrained by nor dependent upon the scientific experience of the past, is based on totally novel technology and particularly those of recombinant DNA technology - the technology which has helped us to embark upon what may be the last industrial revolution!

Modern Biotechnology has already made significant contribution to the health and agriculture sector. Development of several drugs, various pharmaceuticals, vaccines using recombinant DNA technology has given rise to multi billion dollar industry. In addition, PCR based diagnostics has also emerged as an important component of health care.

Since majority of the Islamic countries have their economies based on agriculture, biotechnology has thus immense potential to enhance productivity. The demand of food in Islamic countries of Africa and Asia over the next 25 years is predicted to increase by 40%. This increase will need to come from improvements in agricultural productivity in fertile, marginal, salt affected and rainfed areas. There will be less labour, water and arable land available in agriculture. This situation is a result of declining rural population, mismanagement of water resources, infertility, environmental degradation and above all due to increasing population. In order to meet these challenges innovative technologies such as Biotechnology has to be used to overcome many of these problems.

In the developed world significant achievements have been made in Agricultural Biotechnology especially for developing transgenic crop varieties with specific traits namely insect resistance, herbicide resistance, etc. However, the crops which have been given most of the attention are the ones which are of the interest to developed world namely Soybean, Cotton and Maize. There is relatively less work being done on crops of least developed countries of Africa such as Cassava, Yam, Sweet Potato, Banana, Plantain, etc. It should be, therefore, one of the important aspects of this strategy that such ignored plant species which have direct relevance to food quality in many of the Islamic countries should be given due attention.

Genetic engineering of crop plants (tobacco) was first reported in 1981 in USA. The first commercial product was approved in May' 1994 while BT cotton reached the farmer fields in 1995. There is tremendous increase in the area under GM crops as it jumped from 3.2 million acres in 1996 in are country USA to 145 million acres in 2002 in 13 countries. Canada Argentina and Mexico are the only other countries in which there has been significant increase in area under transgenic crops, although many other countries are starting to increase their use of living modified organisms in agriculture. China has approved a small number of transgenic varieties of cotton and expects to proceed to the commercial production of modified rice in the next two years. India has also reported cultivation of transgenic cotton at pilot scale (Nature, 2003).

In addition, use of traditional biotechnology especially related to tissue culture has special significance for the developing countries as it is a low cost and relatively simple technology. Plant tissue culture has been known for over 40 years. Its basis is the ability of many plant species to regenerate a whole plant from a single somatic cell. Plant cells derived from leaves, roots, shoots, anthers, or meristems can be grown in a test tube filled with artificial growth medium under sterile conditions. The growth medium contains essential minerals and growth hormone. These tissues are grown in controlled conditions (temperature, light) and then regenerated plants can be transferred to soil.
There are a number of different techniques for plant tissue culture.

* meristem culture
* *in vitro* multiplication
* pollen and anther culture
* embryo rescue
* somaclonal variation

Tissue culture technology which is rather simple has been applied to provide virus free plants and micro propagation of plants that grow slowly or do not yield seed.

In national context this technique is particularly useful in vegetatively grown crops and also for floriculture some of which are listed below:

▪ Potato	Olive	Pistachio
▪ Banana	Papaya	Grapes
▪ Sugarcane	Coconut	Root stock of fruit trees
▪ Date palm	Strawberries	Ornamental plants

3. Current Status in Islamic Countries

The level of Biotechnology research in majority of Islamic countries is at a fairly low level. This is largely because of lack of infrastructure, skilled manpower and lack of commitment by the national governments. However, within Islamic countries few countries and few institutions have Biotechnology Centres of Excellence in Biotechnology. Among these countries, Egypt, Malaysia, Turkey and Pakistan have embarked on meaningful programs related to Biotechnology. One of the main constraints is non-availability of trained scientific manpower and financial support. During past few years many governments of Islamic countries have shown keen interest in Biotechnology and have a genuine desire to develop this technology for the betterment of their people.

ISESCO, under its Science Programme, is already supporting promotion of Biotechnology in the Member States. Realizing the complexity of the task, it is must that the ISESCO Centre for Promotion of Scientific Research (ICPSR) support the Centres of Excellence and also establish new Centres which act as a Resource Centre for training and developing the Biotechnology programs in Islamic countries. In this connection, an effective

networking of all the institutions and universities where R&D in Biotechnology is being carried out is a must.

4. Potential for Economic Development

In order to realise the full potential of biotechnology as a frontline area of research and development with an overwhelming impact on society, Muslim Umma have to nurture biotechnology at three distinct levels (i.e., Agriculture, Health and industry). The underlying agenda should be the utilization of research funds jointly and more economically.

Biotechnology Industry should include all components which make use of the modern biological, rather conventional techniques to develop commercial products for agricultural productivity, animal ,or human healthcare, production of fine and value-added novel compounds and pharmaceuticals through genetically modified organisms, food processing and environmental services. However on the other hand, the production of alcohol solvents and compounds of industrial interest through fermentation processes is also regarded as Biotechnology Industry. Indeed these processes fall under the category of conventional biotechnology and are important if plentiful raw materials which are to be used as the starting material for that product are available in the country. While reviewing the scenario of the biotechnology industry in Islamic countries, this point has to be kept in mind.

The innovative capability of Biotechnology is being looked upon as the central pivot in maintaining/expanding the national share in the global economy. In the industrialized world biotechnology has now indeed revolutionized all major sectors of industrial activity. The exceptional dynamism of the science-technology interface is the main driving force of biotechnology. Furthermore the science and technology have been co-related in such a way that the technology is always highly dependent upon its understanding of scientific principles thereby constantly pushing the knowledge base forward concomitantly producing new grounds for technological breakthroughs. Under the present scenario many advanced and sophisticated scientific techniques, technologies and methodologies are being employed daily not only in the industrialized world but also increasingly in the developing countries. Unfortunately this, by no means reflects the scientific and technological capacity of the developing world.

In order to achieve significant success biotechnological innovations has to be followed by a series of dynamic adjustments both at institutional as well as at social levels; including technology transfer, financing, structural and strategic reorganization at enterprise level; improvements in skills by using educational schemes and also reorganization of science and technology policies. In the developing countries like China, India, Brazil, Mexico and Pakistan, a working knowledge of the complex and multiple requirements that should be fulfilled to develop a vibrant, viable biotechnology industry, does exist.

Industrial sector in many Islamic countries is growing at a very slow pace and relies mainly on an agro-based economy. Various Governments of Islamic countries has been encouraging the development of methodologies and institutions for acquiring the cutting-edge technologies like Biotechnology and Information technology. However, the funding position has been such that support of expensive and high-priced technology has been financially

prohibitive. In order to generate a critical mass of expertise, a strong infrastructure and directed support, the critical areas for investment over a period have been outlined

5. Biotechnology as Industry

Due to the multidisciplinary nature of biotechnology and its direct relevance to various bioengineering processes, this can itself be called an industry. The role of biotechnology in industry relies on all three generations of biotechnology. In contrast to traditional food processing industry where only first generation biotechnology is used, all biopharmaceuticals, including insulin, finding and marketing of new medical products and cosmetics, the production of pharmaceuticals and veterinary products, foodstuff for men and animals, in addition to chemical fertilizers and similar products derived from the sea environment, require third generation vectors and it is certainly right to say that many new therapies could not have been possible without such new genetic engineering techniques. *However, it is a fact that all industry related to biotechnology shares a common platform comprised of techniques applied to biological systems.*

At present it is very difficult to identify opportunities for new second generation biotechnological products since the Chinese, Indians and other such countries are producing these products at much lower costs. In this regards not only we, but USA and EU are also struggling to compete and have indeed these economies have lost fermentation capacity since two decades.

It is, however, also certain that competitiveness in Biotechnology Industry will depend on the ability of application of third generation biotechnology. Thus the proposed focus on ‘New Biotechnology‘ will create tremendous opportunities for all biotechnological industries. It is likely that there will be *niche* products for which a competitiveness can be established; among these can be specialized enzymes, fine biopharmaceuticals using biotransformation and amino acids. Considering the possible role of Biotechnological Revolution in Industry following thrust areas could be suggested:

1. Agricultural Biotechnology
2. Health Care and Diagnostics.
3. Pharmcogenomics
4. Industrial Biotechnology including environmental toxicology.
5. Biotransformation including biomining.
6. Bioinformatics,
7. Marine Biotechnology
8. Industry Support Systems: Instrumentation, Chemicals and hardwares.

6. Requirements for the Development of Biotechnology

6.1 Strategies For Developing Biotechnology

It is believed that in our contemporary society Science and Technology are to be central to creating wealth and improving the quality of life of our people. Therefore, governments of Islamic countries should create environment conducive for innovations to achieve the national goals of human resource development, job creation, improving the health standards, crime control, urban uplift, rural development and for regional integrity and should make conscious efforts to upgrade the standards of Science and Technology in general and Biotechnology in particular, in their country.

Principles for the proposed biotechnology strategy

A number of principles will guide the conception and implementation of this strategy, including

- Ensuring that the strategy meets the national imperatives, including job creation, rural development, crime prevention and human resource development
- Focusing specifically on those areas where there is (or is likely to be) a comparative advantage in biotechnology e.g. agriculture
- Develop new programmes that will harness existing national scientific and technological competencies;
- Address issues of biosafety and genetically modified organisms/plants
- Review the strategy constantly in the light of national priorities and international trends and recent advances in biotechnology development

6.2 Human Resource Development

Biotechnology is a multidisciplinary science and therefore, any Biotechnologist apart from having a good basic knowledge of basic molecular biology, requires knowledge in bioinformatics, information technology, engineering, statistics, genetic epidemiology, business management, product development and legal issues. It is true that no one person is likely to be an expert in all these fields, therefore specialists with these above expertise are to be required.

Presently there is an alarming shortage of manpower that is trained in biotechnology. It is very important that immediate steps should be taken to overcome this vacuum. This can be achieved in the following ways:

- Career Opportunities should be established. There should be sufficient job opportunities with comparative remuneration packages to attract the top of the trade peoples/students.
- Fast-tracking for the needed human resources. An active international recruitment programme aimed at first to expatriates living abroad for transfer of technology and secondly offering job opportunities to retired scientists living abroad.
- Improving the current post-doctoral fellowship system by establishing considerable number of postdoctoral fellowships which are competitive to international market so that top of the line people can be attracted.
- Curriculum should be developed to cater the needs for the required human resource. There is a dire need to focus on mathematics and science education at high school level in order to generate a pool of human resource which can be hand-picked for biotechnology training.

6.3 Research and Development Activities

Biotechnology unlike other technologies, has some very unique features and therefore demands special treatment.

Biotechnological innovations or techniques developed for animals can also be applied to human health and even to agriculture or other industrial sectors. Thereby implying that *Biotechnology is Cross-Cutting Technology*. Thus the management of economic benefits can be arranged in such a way as to take advantage of this cross-fertilization characteristics of biotechnology.

When compared with other industries like chemical industry with a n average research intensity of 5% on R&D, or the pharmaceutical industry with and average spending on research as 13%, Biotechnology companies spend 40-50% of revenue on R&D. This makes *Biotechnology as a Research Intensive Industry*. Thereby these two novel and non-peculiar characteristics of Biotechnology Industry are likely to deny any country the opportunity to exploit the benefits of this tremendous technology if isolated R&D activities are organized around traditional sectors like agriculture, health and industry. The key components of modern biotechnology are:

- **Genomics:** the molecular characterization of all species;
- **Bioinformatics:** the assembly of data from genomic analysis into accessible forms;
- **Transformation:** the introduction of single genes conferring potentially useful traits into plants, livestock, fish and tree species that are then called transgenic or genetically modified organisms;
- **Molecular Breeding:** the identification and evaluation of desirable traits in breeding programs by the use of marker assisted selection;
- **Diagnostics:** the use of molecular characterization to provide more accurate and quicker identification of pathogens;
- **Vaccine Technology:** use of modern immunology to develop recombinant DNA vaccines for improving control of lethal diseases.

7. Identification of Short term (5 years) ; Medium term (5-10 years) and Long term (15 years) technologies to be developed

The vision of biotech policy for Muslim Ummah should be to harness the vast potential of Biotechnology as key contributor to the development of Islamic world. Biotechnology strategies, which have been proposed under several focus areas, if implemented, will usher a new era in the development of the Islamic countries.

7.1 Agriculture, Plant and Animal Biotechnology

7.1.1 Crops

Major thrust on:

- Higher productivity
- Enhanced nutritional status
- Value addition to crops as therapeutics

***Stability against stresses*:** Insect pests and diseases still continue to cause heavy crop losses. Focussing on specific crops and problems, transgenic and / or marker assisted selection approaches shall be developed and used to evolve stress tolerant crops varieties.

***Yield enhancement*:** Three approaches are contemplated to raise the genetic ceiling to yield viz (i) exploitation of hybrid vigour (ii) search for and use of still unexploited, yield related gene blocks (QTLs) and (iii) engineering of biosynthetic pathways of starch, protein and oil. Whereas male sterility by anther/ pollen specific expression of toxin/protoxin genes would be engineered to extend hybrid technology to nonhybrid crops like Brassica, marker associated gene blocks relating to yield shall be identified using QTL techniques in landraces and progenitor species of crop plants. Manipulation of key/rate-limiting enzymes in the pathways of starch etc. will be attempted for achieving new yield thresholds. Development of map based and marker assisted technologies for precision breeding in crop plants like rice, wheat Brassica, chickpea, etc. special focus on designer crop plants what carry specifically selected genes with traits that allow them to thrive in particular environment or produce valued consumer characteristics through the application of structural/ functional genomic approaches.

***Nutritional quality improvement*:** Exotic and indigenously identified candidate genes to be exploited to enhance the level of essential nutrients such as iron, zinc, vitamins, balanced proteins etc, in major crops correction of antinutritional factors known to exist in specific pulse and oilseed crops. A time bound mission to be launched.

Edible vaccines for diseases, particularly for cholera, hepatitis and rabies would be developed and tested for large scale production.

If the centres are established in at least for different countries as mentioned and work on Genomics and Bioinformatics gets started, the next phase should be production of transgenic varieties of some of the crops like wheat, rice, Brassica, moongbean, pigeonpea, cotton, patato, tomato, banana, and some vegetable like cabbage, cauliflower etc. would complete field assessment and some of them would be ready for large-scale seed production by 2008. Nutritionally enhanced potato and Bt cotton are among the important ones.

Transgenic wheat with more protein content and better quality and also higher lysine content and marker-assisted breeding programme is expected to be introduced in farmers' field by 2005-2008.

7.1.2 Plant tissue Culture

- Developing complete package for improvement of priority crops – Potato, Olive, Pistachio, Banana, Papaya, Grapes, Sugarcane, Coconut, Root stock of fruit trees, Date palm, Strawberries, Ornamental plants, Tea Apple Spices, Medicinal plants.

- Continued large scale production of forest tree species

- Development and use of micropropagation for multiplication of root stocks and scions in selected varieties of fruit crops like mango and hairy root culture for production of secondary metabolites in general and those relevant to food industry.

- Promoting application for tissue culture technology at grass root level and its adoption by the end user.

- Utilization of tissue culture for enrichment of genetic diversity.

- Genetic manipulation of cell culture in forestry for disease resistance and reduction of regeneration time.

7.1.3 Biofertilizers and Biopesticides

Transgenic biofertilizers and biopesticides, particularly botanicals some of which already have been developed by countries like Pakistan, would have been filed tested for commercial production.

7.1.4 Bioprospecting and Molecular Taxonomy

It is expected to complete the prospecting and molecular characterisation and documentation of the economically and ecologically important hot spots of biodiversity in the countries.

7.1.5 Animals

- Development of recombinant diagnostics and vaccines for major disease in livestock/fish and establishment of required cell lines and their banking facilities.

- Transgenic animals can be employed either as biofactories for the production of commercial products or as living models for the study of human disease and evaluation of pharmaceuticals. The use of transgenic animals for these purposes can be more economical or in the case of human disease and drug models more realistic than are conventional alternatives.

- Transgenic for productivity improvement and disease resistance, development of experimental animal models for specific important diseases and desirable products / pharmaceuticals.

- Techniques for cloning, both embryonic and somatic, by multiplication of elite animals.

- Development and formulation of improvised animal/fish feed.

- Development of genetics markers for animal breeding programmes.

- Considering the importance of the mouse as the model organism for human genetics, and the paucity of expertise in the country in the area efforts will be made to initiate and support research in mouse genetics.

7.1.6 Environment and Biodiversity

- ***Collection, conservation and sustainable use of biodiversity*** : A large project on characterization of natural resources by DNA fingerprinting, assessment of their relatives potential and improvement for enhanced performance to be launched.

- Bioremediation – location-specific projects

- Waste recycling and wasteland reclamation as large-scale demonstrations

- Development of biosensors, bioindicators

- Ecosystem specific project with biotechnological interventions – desert, island, coastal, mangroves and mountain, for damaged ecosystems.

7.1.7 Biofuels and Bioenergy

- Production, demonstration and utilization of biomass and for generating raw material for bioengineering for the production of liquid gaseous fuel – a mission mode project

- ***Bioengineering***: viable bioengineering process to be developed for up scaling and pilot production of alternative source of energy involving fermentation technology with the application of identified microorganisms.

7.1.8 Bioprocesses and Product Development and Bioinstrumentation

- Biotechnology products being health friendly and bioprocesses for them being environment safe are receiving increasing attention. Therefore efforts will focus on:

a. Development of small peptides/proteins/carbohydrates present in animals/humans as therapeutics. **b**. enzymemediated synthesis of chiral drugs c. microbe/ enzyme-based processes specially for paper, leather, arsenic etc, for pollution control. **c**. microbe-engineered/rDNA processes for biomolecules/drugs **d**. microbes/ enzymes for waste disposal especially plastics **e**. streamlining of guidelines for biotech products.

- Biomedical instruments are fundamental to enhance biotechnological activities including research and development and product development. A close collaboration between electrical engineering. Computer science faculty/ professional and biomedical/ agricultural faculty and researchers is needed in the country. Special efforts would be made to integrate diverse discipline/professional required to attain self- reliance in this field.

- Spatial and temporal control of biofilm formation , analysis of auinducers (e.g. homoserine lactones as predominant signals) and use of new optical tools including confocal laser microscopy for assessment of complex community structures and their use in environmental and industrial sector would be given special boost. Quorum, sensing as a general phenomenon in pathogenesis would be encouraged.

Identification and development of crops for bioengineering for biofuels and bioenergy would take at least 2-5 years for completion of various objectives.

7.2 Health

7.2.1 Medical Biotechnology

1. Continued efforts on newer vaccines specially for malaria, tuberculosis, cholera, HIV, rabies and Japanese Encephalitis which should be ready in the next 2-5 years.

2. Multidisciplinary projects on genes therapy and stem cells research

3. Suitable, cost effective diagnostic for infectious genetic and malignant disease/disorders, low cost kit for steroid and reproductive hormones. Promoting indigenous development/ production of probes. Primers/ ELISA plates, monoclonals, enzymes and other reagents required for diagnosis of local strains of causative agents for HIV malaria hepatitis, cholera tuberculosis.

4. Developing strategies for prevention and cure of diseases induced by faulty diet, lifestyle and immunological disorder such as Juvenile diabetes, coronary heart disease obesity and anemia.

5. Molecular medicine approaches for caner and cardiovascular disorders

6. Microbial genomics with special reference to emerging and re-emerging diseases

7. Research into reproductive human health and contraception.

7.2.2 Neurosciences

- Research on neurodegenerative disease, such as Alzheimer's disease, Parkinson's disease and motor neuron disease which would include study of molecular genetics of some of these disorders as well as understanding the etiopathogenesis of these disorder particularly with respect to the role of environmental toxins in the sporadic forms of these diseases.

- Consequences of HIV infection in the nervous system (neuro-AIDS) constitute an important areas for research.

- Another area of concern relates to childhood related disorders (such as autism, attention deficit hyperactivity syndrome and dyslexia) considering the demographic profile in the countries. Research on these disorders using modern imaging techniques is important.

- Computational neuroscience research would focus on development of computational simulations of neural information processing for understanding brain functions and development of newer computational tools such as neural networks etc through the understanding of brain function. In addition, focus would be on "Neuroinformatics" an emerging area of neuroscience so far not initiated in the country.

Up scaling and commercialization of PCR-based diagnostics could be completed in 2-3 years time. Gene therapy trials against cancer can be initiated.

Up scaling and probably commercialization of the newer genomics-based technologies (e.g. micro arrays) would commence in 1-2 years time.

7.2.3 Stem Cells

a- Introduction:

Stem cells are the most primitive cells found in a living body. These cells have capacity of unlimited or prolonged self-renewal that can produce at least one type of highly differentiated descendent. However under selective experimental conditions, these cells can be induced to transform into at least 210 types of tissue specific cells.

There are two main types of stem cells, embryonic stem (ES) cells and adult stem cells. The human embryonic stem cells are taken from embryos at 100 cell (blastocyst) stage and are cultivated in laboratory conditions to get the desired type of cells. Adult stem cells, on the other hand, are taken from adult tissue, e-g, umbilical cord blood. The adult stem cells are not so versatile as embryonic stem cells but they can be easily obtained and are controversy free.

b- Justification of stem cell research:

Stem cell research is the wave of future in biomedical field. It has the potential of curing nearly 130 million people in USA alone. Stem cells have the potential of treating a problem in totality whereas drugs are effective against a single aspect of disease. Scientists have succeeded in producing insulin from stem cells. Even more notable is the repair of damaged tissues by introduction of stem cells. Success has been achieved in treating heart

patients and persons with nervous tissue disorders. In fact, it is impossible to fully comprehend the extent to which stem cells can be used as a tool for alleviation of human diseases.

At present, all the advances in this field have been made in developed countries and mostly by multinational companies. The products or cost of treatments are highly prohibitive and simply out of reach of a common man in developing countries. There is a need to establish an infrastructure for stem cell research in Islamic countries to meet the local requirements. This infrastructure can also be used to earn useful foreign exchange by supplying the products to other countries.

c- Thrust areas:

- Establishment of stem cell banks for treatment of fatal blood diseases such as leukemias by replacement of sick stem cells with healthy stem cells.

- Use of stem cells as a tool for drug development is a very promising area. The stem cells could form the first testing platform before moving on to laboratory animals and human subjects.

- Use of stem cells as tools for repair of damaged tissues, such as damaged heart muscles, spinal cord injuries, burns and rheumatoid arthritis. In fact, stem cells can even be used for generation of whole organs, such as a limb.

7.2.4 Medicinal and Aromatic Plants

Islamic countries like (Pakistan, Malaysia, Maldives, Turkey, Iran and Central Asian states etc.) are rich in Medicinal Plants resources as well as in its uses and there is a growing trend of use of herbal products globally. Pakistan and Egypt are among the top eight exporting countries of crude drugs. A number of herbal products should be in the market, these should be in the form of new formulations, immunomodulators and drugs. The diseases like septic shocks diabetes malaria and cancer can be addressed through herbal medicines.

7.2.5 Herbal Drugs and Nutraceuticals

Genetic engineering of medicinal plants to give uniform expression of action constituents with minimum seasonal/climatic variations. To develop crops with value addition in terms of proteins, minerals, vitamins and biomolecules of therapeutic and also of industrial interest.

7.3 Industry Environment

7.3.1 Industry

More Public-Private partnership will be forged in order to develop joint R&D programmes for commercially viable projects. Production units for recombinant biologicals, DNA chips and related materials could be set up.

Financial Resources needed and Economic Benefits likely to Accrue. Biotechnology can be shaped into a premier precision tool of the future for creation of wealth and ensuring social justice – especially for the welfare of the poor. To alleviate poverty a major well directed effort with significant investment, for harnessing biotechnological tools for generation of products, processes and technologies to enhance the efficiency and productivity and cost effectiveness of agriculture, nutritional security, molecular medicine, environmentally safe technologies for pollution abatement, biodiversity conservation and bio-industrial development have to be launched.

7.4 Problems related to Intellectual Propert Rights (IPR), commercialization and Ethical Issues

7.4.1 Biosafety, Ethical And Proprietary Issues

Establishing transparent, expeditious and scientific principles of biosafety and rigorous implementation of the biosafety guidelines to be ensured. Wherever necessary testing, containment and certification facilities to be established. For safeguarding ethical, legal social and economic issues relating to biotechnology research, product testing of GM food, labelling, policy guidelines to be perfected and regionally implemented.

7.4.2 IPR In Biotechnology

Islamic countries will have to take initiatives to gram appropriate strategies and policies in order to maximize the benefit and minimize the disadvantages from the new regime. It is therefore, essential to :

- Enhance the knowledge of various issues regarding patents amongst the various cross sections, of the people by organizing suitable time-bound, tailor made training/awareness programmes at national and international levels.

- Create adequately trained and knowledgeable IPR professionals in the area of Biotechnology

- Stimulate and encourage innovative activities for promoting IPR

- Augment mechanisms for effective protection and facilitation of IPR

- Expeditiously disseminate the information using print media, internet, seminar and symposium

- Institute techno market surveys feasibility studies patent related database and services customized information services patent networking invention review committees future vision report and technology transfer services

- Evolve policies for IPR in various emerging issues

7.4.3 Risk Assessment Strategies

Risk may be defined as the likelihood that an organism introduced into the environment may cause harm to that environment and can be seen as comprised of two factors:

a. the consequence of a particular event
b. the likelihood of the event occurring

The risk assessment strategies adopted by all the internationals and national systems are very similar, and are predominantly based on familiarity with the wild-type unmodified, organism and the likely impact due to the changed characteristics of the organism.

The plasmid is one of the main vectors used in transferring to a plant cell, yet its normal host is a plant pest. The regulatory system in some countries is triggered by its use simply because it is derived from a pest, even though the plasmic actually used does not contain the genes that would assist the bacterium. A trigger is simply a mechanism for starting the risk assessment processes.

The costs of regulation of modern biotechnology are high, both to a government (that assures that possible adverse effects of living modified organisms on the conservation and sustainable use of biological diversity, taking also into accounts risks to human health are minimised) and to the applicant (for permission to use or release the organism). Governments vary as to their approach to recovering the cost of the procedures.

7.4.4 Risk Management

Risk management, which includes the system by which decisions are made is considered to be separate from risk management "Risk management is the process of identifying, evaluating, selecting and implementing actions to reduce risk to human health and to ecosystems. The goal of risk management is scientifically sound, cost effective, integrated actions that reduce or prevent risk while taking into account, social cultural, ethical, political and legal considerations.

7.4.5 Potential Benefits of Genome Project Research

Rapid progress in genome science and a glimpse into its potential applications have spurred observers to predict that biology will be the foremost science of the 21st century.

Technology and resources generated by the Human Genome Project and other genomics research are already having a major impact on research across the life sciences. The potential for commercial development of genomics research presents U.S. industry with a wealth of opportunities, and sales of DNA-based products and technologies in the biotechnology industry are projected to exceed $45 billion by 2009 (Consulting Resources Corporation *Newsletter*, Spring 1999). Some current and potential applications of genome research include

a- Molecular medicine

- improved diagnosis of disease
- earlier detection of genetic predispositions to disease

- rational drug design
- gene therapy and control systems for drugs
- pharmacogenomics "custom drugs"

b- Microbial Genomics

- new energy sources (biofuels)
- environmental monitoring to detect pollutants
- protection from biological and chemical warfare
- safe, efficient toxic waste cleanup
- understanding disease vulnerabilities and revealing drug targets

c- Risk Assessment

- assess health damage and risks caused by radiation exposure, including low-dose exposures
- assess health damage and risks caused by exposure to mutagenic chemicals and cancer-causing toxins
- reduce the likelihood of heritable mutations

d- Bioarchaeology, Anthropology, Evolution, and Human Migration

- study evolution through germline mutations in lineages
- study migration of different population groups based on female genetic inheritance
- study mutations on the Y chromosome to trace lineage and migration of males
- compare breakpoints in the evolution of mutations with ages of populations and historical events

e- DNA Forensics (Identification)

- identify potential suspects whose DNA may match evidence left at crime scenes
- exonerate persons wrongly accused of crimes
- identify crime and catastrophe victims
- establish paternity and other family relationships
- identify endangered and protected species as an aid to wildlife officials (could be used for prosecuting poachers)
- detect bacteria and other organisms that may pollute air, water, soil, and food
- match organ donors with recipients in transplant programs
- determine pedigree for seed or livestock breeds

f- Agriculture, Livestock Breeding, and Bioprocessing

- disease-, insect-, and drought-resistant crops
- healthier, more productive, disease-resistant farm animals
- more nutritious produce
- biopesticides
- edible vaccines incorporated into food products
- new environmental cleanup uses for plants like tobacco

8. Salient Features of the Strategy for Developing Biotechnology in Islamic Countries

a) Nurturing leads of potential utility:

1) Life technology development leads emerging from the bioscience enterprises will be vigilantly identified and fostered in three major areas; agriculture, healthcare; and environment. Widely available information resources will be developed for this interface via regulated and comprehensive repositories, systemic biological standardization, and patent support mechanisms. Industrial transitions will be facilitated with large-scale demonstrations and seed partnerships. Proactive steps will be taken to address societal concerns by establishing transparent mechanisms of systematic public dissemination of bio-information, and by putting into place comprehensive stringent frameworks for both bioethics and bio-safety.

2) Necessary informational resources should be systematically developed through data banks, inventories, and germ plasm repositories.

3) Human resource development in bioscience and biotechnology should be enhanced to achieve widespread excellence in both teaching quality and support resource.

4) Awards and incentives could be instituted to recognize meritorious efforts. Selected mission in identified areas would be launched. Each Muslim country should have a focal point on Biotechnology.

5) ISESCO may establish a centre like Islamic Centre for Biotechnology and Genetic Engineering (ICBG) that may be housed in any Member State.

6) Support the creation of a biotechnology centres in at least four of the countries. These centres will ensure that benefit is drawn from the scientific cadres of the university and provide the centres' infrastructure via specialized commissions. This support could be announced by any Islamic financing body and organizations desirous of housing the center could write proposal to this effect.

7) The Center would be a meeting point for researchers in the filed of biotechnology from the Islamic world. It would organize an annual conference focusing on one of the technical fields of biotechnology. Researcher would then present their inventions, exchange scientific expertise and foster scientific co-operation among Islamic countries.

8) The Center, which may recognized by ISESCO, may facilitate to train students and researchers in the filed of biotechnology, award high degrees in this speciality, and enable faculty members to benefit from scientific sabbaticals.

9) The center would be supervised by a member of biotechnology scientists from Islamic countries. The directorates would present an annual report on the scientific achievements and financial situation of the center.

10) The widely spread bioinformatics network would be maximally utilized to ensure connectively as also sharing and exchange of information, nationally and internationally, data analysis, software development and for dissemination of

information. The required infrastructure facilities would be strengthened and created wherever necessary.

11) Molecular and genetic phenomena associated with processes of infection, progression of disease (infectious and systemic) and the underlying pathology, both in animals and plants.

12) Molecular approaches to community dynamics in crop rhizosphere ecosystems to assess soil-dependent and genotype-dependent changes and utilization of this information in use of indigenous and genetically modified microorganisms.

13) Redirect physiology of root cells towards a richer microbial community in rhizosphere

14) Development of suitable micro-assay and high throughput assay systems to assess the therapeutic potentiality of the naturally existing and structural of functional characterization of the molecules

15) Metabolic engineering using recombinant DNA technology to enhance the activities of cells by manipulating its metabolic pathways and enhancing the potential of organism-producing antibiotics etc.

16) Tissue engineering for the development of biological substitutes to restore, maintain or improve human tissue function – employing the tools of biotechnology and material sciences as well as engineering concepts to explore structure function relationships in mammalian tissues would be a challenge. This emerging technology could provide for substantial savings in healthcare costs and major improvement in the quality and length of life for patients with tissue loss or organ.

17) Exploring the potential of stem cells for therapeutic purpose.

b) Bringing bioproducts to the marketplace:

Innovative policies will be developed and implemented, in conjunction with other government departments and agencies, to enhance the biotechnological landscape for investment to champion Islamic biotechnology in the global marketplace in general and Islamic world in particular, and to design innovative as well as defensive strategies for global intellectual property rights. Systematic interventions at this level will include pilot-scale production and training units, short as well as long term partnership with the biotechnology industry, and coordination of public investment in essential products for society with low commercial returns. We aim at achieving excellence in this field, indigenous self-reliance and international competitiveness.

c) Genomics: Structural and Functional

1) Exploit the knowledge created by Human Genome Sequencing and also that of some pathogenic organisms and parasites so as to generate diagnostic and therapeutic products of special relevance for the country mostly for dreadful diseases like malaria, HIV tuberculosis, cancer and brain disorders.

2) Identifying genomic factors responsible for genetic disorders, development of molecular diagnostics and personalized drugs for the treatment, understanding of the biochemical pathways of the diseases leading to a safe and powerful treatment regime. Comparative genomics, functional and structural genomics, studies of single nucleotide polymorphism, proteomics, data annotation, integration and analysis.

3) Creation of DNA polymorphism maps and databases of the Muslim Ummah for predictive and preventive healthcare.

4) Creation of microarray facilities for defining the expression and functions of genes. For important crops like rice, wheat, Brassica, chickpea, a map based marker assisted technology development for precision breeding, as well as gene identification through in situ molecular hybridization.

5) Functional Genomics: To exploit the sequence information we have to understand the specific biological functions encoded by a sequence through detailed genetic and phyenotypic analysis. For this purpose, genetic resources, e.g. mutant, isogenic lines, elite breeding lines, and high throughput facilities such as microarrays and proteomics would be developed. The programme would initially focus on selected high-priority traits such as tolerance to biotic and abiotic stresses. Bioinformatics capability for analytical and computational ability to infer gene function based on sequence information is equally essential. To enhance scientific knowledge and to discover new genes for crop improvement, a national functional genomics program is needed to make information from functional genomic studies broadly available to address practical problems.

6) Development of new algorithms, softwares and tools for data mining and data warehousing applications especially related to human, plant and microbial genomes; establishment of small software groups and companies to develop competence for identification for useful genes; strengthening the infrastructure for supporting complex and computationally intensive problems such as protein folding and other problems in structural biology; and establish linkages with epidemiological data to discover the genetic basis of several diseases affecting certain communities in Muslim Ummah.

7) To set-up dedicated network centres for developing data warehouses, data design, data mining from single and multiple databases and mirror sites to decipher the international data available in public domain to correlate the function of individual sequences.

8) Exploitation of microbial genome information using strong bioinformatics machinery. These goals would be realised through an institutional framework of a national level autonomous bioinformatics centre.

d) Biotechnology for Societal Development

A number of projects in directed to specific sectors, locations-specific and based on natural resources, would be implemented. It is expected that these projects would generate a employment opportunities in the rural areas, particularly for women. The biovillage concept would be significantly useful. Genetics counselling programmes would be expanded further.

e) Developing human and financial capacities in biotechnology sciences

1. Linking Islamic countries with each other in the field of research, studies, expertise, information and biotechnology-related matters and linking the Islamic world with the rest of the world.
2. Unifying the Islamic perception of the production and use of biotechnology
3. Sensitizing the Muslim society about the definition of biotechnology, its applications, benefits and dangers from a perspective that takes into consideration the ethical aspects of this technology.

9. Conclusion

Specific Objectives of the Strategy could be summarized as follows:

1. Developing human and financial capacities in biotechnology sciences.
2. Linking Islamic countries with each other in the fields of research, studies, expertise, information and biotechnology-related matters, and linking the Islamic world with the rest of the world.
3. Unifying the Islamic perception of the production and use of biotechnology.
4. Sensitising the Muslim society about the definition of biotechnology, its applications, benefits and dangers from a perspective that takes into consideration the ethical aspects of this technology.
5. Defining the priorities scheduled in the axes of biotechnology and that entail the use of molecular indicators, disease diagnosis, genetic engineering and genomics.
6. Establishing a mediation role for the Islamic world in matters of copyright and other arbitration fields at the international level
7. Co-ordinating among Islamic countries in the field of the legislation governing biosafety (genetically modified organisms and disposal of toxic waste), and preserving biodiversity.
8. Endeavouring to develop the sector of biotechnology in the Islamic countries that lag behind in development to enable them to keep pace with other Islamic countries.
9. Granting priority to the development of a biotechnology that facilitate the achievement of food security in the Islamic world.
10. Encouraging the private sector through incentives to access the field of biotechnology.

10. An Action Plan for Achieving the Objectives of the Strategy:

1. Creation of a centre or centres dedicated to the development of biotechnology in Islamic countries through research, training, technical consultations, co-ordination, legislation, commission and creation of specialised excellence centres.
2. Devising of mechanisms to finance the various activities of biotechnology.
3. Creation and development of laboratories, equipment and tools necessary for the progress of biotechnology
4. Creation of a database for exchange information on biotechnology among Islamic countries.
5. Devising of joint research projects.
6. Compilation of a legal reference background to support legislation on biological safety and IPR issues in Islamic countries.
7. Introduction of biotechnology sciences in educational curricula at various stages.
8. Drawing of benefits from Islamic ties in and outside the Islamic world to develop biotechnology and co-ordinate with international organizations.
9. Establishing as well as strengthening biotechnology training centers and laboratories to develop trained and skilled manpower.
10. Creating databank on various useful technologies and information like improved seeds, useful varieties, etc.
11. Mobilization of funds for biotechnology research activities from financial institutions, trusts, banks and other investment opportunities.

Islamic Educational, Scientific and Cultural Organization in coordination with the Expert Group, presented by the biotechnological scientists and researcher from the Member States, will devise the action plan of the Strategy. Aspects relating to other sector, will be dealt through active coordination with concerned authorities in the related areas. Biotechnology sciences will be introduced in general educational curricula in coordination and biotechnological education will be strengthened through regular updating the contents of curricula and textbooks in coordination with education sector. General awareness on useful biotechniques and terminology will be enhanced through wide publications, media campaign, exhibitions, etc. on biotechnology. Ethical aspects relating to biotechnology research and its applications will be covered through debate among scientists and researchers in biotechnology and genetic engineering and ethical guidelines will be prepared in liaison with the Islamic Body on Ethics of Science and Technology (IBEST). In order to protect people and environment from harmful effects rigorous implementation of a bio-safety protocol will be ensured and awareness will be enhanced through establishment of biosafety information network, advisory services and utilizing the scientific media, available. Research will be concentrated on peaceful use of biotechnology, and necessary regulations which prohibit use of biotechnology for biological war fare purposes.

Suggestions of the Member States on the Strategy for Development of Biotechnology in Islamic Countries

Hashemite Kingdom of Jordan

a. Strategy for Consolidating Biotechnology in Islamic Countries

1- Support the creation of a biotechnology centre in one of the Islamic universities that would serve as a headquarters of this centre and ensure that benefit is drawn from the scientific manpower of the university, and provide the center's infrastructure via a specialised commission. This support would be announced by ISESCO and universities desirous of housing the centre could write proposals to this effect.

2- The Centre would be a meeting point for researchers in the field of biotechnology from the Islamic world. It would organise an annual conference focusing on one of the technical fields of biotechnology. Researchers would then present their inventions, exchange scientific expertise and foster scientific co-operation among Islamic countries.

3- The Centre would be adopted by ISESCO as a facility to train students and researchers in the field of biotechnology, award high degrees in this speciality, and enable faculty members to benefit from a scientific sabbaticals.

4- The centre would be supervised by a number of biotechnology scientists from Islamic countries. The directorate would present an annual report on the scientific achievements and financial situation of the centre.

5- Compile a database on hereditary diseases that result from the marriage of relatives in Islamic States and conduct a classification of these diseases, and initiate projects that have medical merit in the treatment of hereditary diseases, or an economic importance such as plant improvement in Islamic countries.

State of the United Arab Emirates

Summary of the Ministry of Education's Proposals for the Strategy for Promoting Biotechnology in Islamic Countries

The adoption of a general strategy for information technology, focusing on technological industries, and devised within the framework of what policies determine in the field of information technology infrastructure, training, education, research, development and use of technology in Islamic countries, will have a great impact on the technological industries that could be created.

Islamic countries may adopt two five-year plans of which the objectives would be to:

1- Enhance administrative performance
2- Improve the competence of government institutions
3- Provide highly specialised technological information
4- Develop the base structure of information
5- Provide rich information sources for Islamic societies

The fields of action of the plan can be set as follows :

1- To determine criteria that would be adopted as a support structure for the five-year plan
2- Scientific training and education and report drafting
3- Production of information technology
4- Consolidation of infrastructure for technology use, training and development.

The base structure of technological industries relies on three elements, namely specialised manpower, development and research activities and the availability of communication channels and the necessary equipment.

In order to learn about the experiences of Islamic countries in determining these policies, the Malaysian plan may be used as an example. This plan was geared to :

1. Develop adopted levels and criteria
2. Develop databases
3. Develop networks in the government sector
4. Consolidate centres for the training of experts in technology
5. Reinforce computer protection systems
6. Raise technological awareness

It is worth noting that countries of East Asia were largely successful in overcoming the financial crises that confronted them in 1998. Today, they feature among the most technologically developed countries, a status they were able to achieve by adopting effective policies and providing the necessary infrastructure for these industries.

Therefore, it is advisable to devise an international information technology for Islamic States where all countries would participate via their public and private sectors. However, as a first step, a high committee for information technologies (NTIC) may be created within the Islamic Educational, Scientific and Cultural organisation with the following objectives :

1. Formulate a national strategy for the optimal utilisation of computers
2. Prepare a strategy for the development of information centres in Islamic states
3. Determine the criteria and general conditions for the generalisation of computer use in government institutions in these countries.
4. Develop technological industries in these countries
5. Provide technical advice and expertise to these countries in training and other fields.
6. Support research activities in computer-related fields.

In addition to the above-mentioned committee, three commissions would be set up to support it. These would be the Administration and Implementation Commission (AIC), the Education and Training Commission (ETC), and the Technological Operations Commission (TOC).

Devising a strategy for information technology has become a necessity for Islamic countries. Some aspects have, however, to be taken into consideration. Technological industries are an intensive activity and require the knowledge and services of experts. Focusing on technological industries requires an in-depth study, and there is a strong need to devise a strategy for defining the ways and fields of technological applications.

Islamic Republic of Iran

ISESCO Biotechnology capacity building

Overview

It was recognized that Islamic countries were deriving only limited benefits from biotechnology due to the low public awareness and participation declining investments in the public and private sectors research and development.

Suggestion

ISESCO Biotechnology capacity building group could establish to bring :

1) Bridging the information gap between Islamic countries,
2) Public awareness and participation regimes,
3) Effective regulatory policies based on Islamic culture,
4) Bio-safety
5) Bioethics.

ISESCO Biotechnology Task Force

Biotechnology has been a subject of great public interest overview in recent years due to its crucial effect on development, IROST, strongly recommends that the core strategy of the ISESCO meeting in Libya geared to ensuring that biotechnology are effectively mainstreamed into the development policies and programmes of Islamic governments. For this purpose, a Biotechnology Task Force could establish to bring the following assets :

1- Intellectual leadership in the case of biotechnology between Muslim countries,
2- An open and transparent forum for exchange of views,
3- Communications channels through regional nodes,
4- Catalytic function leading to practical biotechnology research for development initiatives,
5- The Task Force would be prepared be convene a group of advisors to prepare a framework.

Kingdom of Bahrain

The Strategy for Biotechnology

Thank you for your letter concerning suggestions on the programme of biotechnology. Here are some points which I wish would contribute to the development of this programme:

1. Suggestions:

a. Determining the strategic objectives of the programme and the relevant proposal: focusing on the researches supporting food industry and pharmaceuticals, and developing agricultural produce.

b. Allotting a budget with the purpose of shoring up scientific research in this field. A jury will select, in accordance with established criteria, researches that are deserving of support.

c. Establishing communication means between universities, research centres, and the benefiting parties: governmental institutions and the private sector alike.

d. Elaborating an information network and a standard database accessible to all, through a website intended for the programme on the Internet.

2. Concerning experts, a teaching staff member specialised in this field will join the department as from September 2003. We will provide you with the required information upon confirmation of his joining us.

Please accept my ample gratitude and the assurances of my highest consideration

Republic of Chad

Elaboration of the Strategy for the Promotion of Biotechnology in the Islamic States

Biotechnology is referred to as the branches of science that use micro-organisms in order to extend the genetic potential of animals and vegetables alike.

In the Islamic states, strategies for the promotion of biotechnology have to be reconsidered, especially at this context of globalization. There is a myriad of techniques, but it seems that scientists are less preoccupied about the ethical aspect. Already, there is a growing awareness among people that biotechnological products are not without innocuous effects.

In fact, with the various branches of biotechnology, the developed countries are rife with almost incurable diseases and malformations affecting human beings, animals and vegetables.

These anomalies are the corollary result of the emergence of the genetically modified organisms (GMO) and cloning. From an ethical point of view, the use of these techniques is unwarranted. Hence, many developed countries deemed it right to ban them, at least officially.

Taking into account all this, the Islamic countries will have to go on about the most lawful branches of biotechnology, where there are less limitations thereon.

1- For an increase in agricultural produce, we can use the most advanced techniques such as artificial insemination and the permissible transferring of the embryo of some animal species. These two techniques have made effective contributions to the promotion of animal productions (animals that are highly productive: meat, milk, wool, etc.)

This is thanks to the importation of semen that are of a genetically high potential, as of the embryo, in order to inseminate them in females in countries like Morocco, Tunisia, Libya, Abu Dhabi, Senegal, Sudan, etc.

Since these products, especially those resulting from the transferring of the embryo, are very sensible, it is necessary to bring into operation some measures, with the aim of making these techniques more viable; namely, prerequisites in terms of water and food production and cleanness, and climatic and eugenic conditions improvement. This will involve high production costs, but the results justify the means; because it ensures self-sufficiency in terms of proteins.

On the other hand, there are other less onerous techniques such as the importation of highly productive species living in the same region, crossing breeds in order to give evidence of the attributes of rusticity they have in common.

The instance of the United Arab Emirates is worth mentioning, because it has been a great success. In fact, in these countries, some scientists discovered that some inseminated species that adapt to important temperature changes, taking into account that heat is one of the major constraints as regards poultry farming.

2- Similarly, in plant biotechnology a great progress has been achieved, so much so that there is, at the present time, a variety of plant species distinguished as having a genetically high potential.

Thanks to biotechnology, species that were, in the past, less productive can, henceforth, yield satisfactory products in terms of quantity and quality. But with these progresses, we are confronted from downstream with several malformations. Hence, the indispensability of studying every facet of biotechnology.

3- Human Biotechnology:

It is possible that the Islamic states use gene therapy, given that this is a highly advanced technique which cures hereditary diseases. On the other hand, human cloning should not be used, because the result obtained was individuals with terrible malformations.

from an ethical perspective, this causes also a problem. This technique is altogether banned, at least officially, in most of the Islamic countries.

Animal and plant biotechnologies contribute to self-sufficiency, provided they are checked, in terms of foodstuff and food security. As far as human biotechnology is concerned, human welfare hinges on genes therapy.

The Islamic states have enough economic and scientific resources that enable them to avail of biotechnology in the most judicious way.

Thus, following the Islamic concept, we can achieve food self-sufficiency; and, consequently, food security. Further still, the treatment of hereditary diseases, involving gene therapy, constitutes, in addition to the previous objectives, an all the more urgent need, given the globalization context through which we are wading.

Republic of Tunisia

Proposal of Scientific Centres Specialised in Biotechnology

We welcome all commendable endeavours to develop biotechnology in the Islamic world as these efforts reflect our determination to master and control sciences and advanced technologies. They also translate our desire to consolidate these technologies with a view to using them in serving the objectives of global development, improving the lives of citizens and providing the necessary conditions of a decent life at an age where sciences and advanced technology herald drastic changes in human societies and their lifestyles.

Since biotechnology comprises many other terms that differ according to fields of application, namely applied biology, applied biochemistry, applied genetics, enzyme technology, industrial and applied organic biology and genetic engineering, modern developments in biotechnology have attracted a fair share of interest from scientists and research centres in developing countries, which countries hastened to adopt strategies and national schemes for biotechnology, as was the case in Tunisia.

We believe that mastering sciences and technical expertise in biotechnology and their utilisation in economic development fields may serve in improving the productivity of development efforts in the agricultural field and environment-related industries, to achieve food security, participate in the economic cycle and obtain a share of the added-value generated by trading in agricultural products, food and pharmaceutical industries.

We believe that it is high time to work seriously towards laying down a clear and unified strategy for consolidating biotechnology in the Islamic countries.

Proposal of elements to be included in the Strategy

- Laying down national structures and support entities that would propose strategies and all aspects related to co-ordination, follow up of implementation, scientific and technological capacity building and reinforcing ties and interaction between scientific research organs and productive social sectors.

- Devising of mechanisms and incentives for further co-operation and co-ordination among research centres and organs in charge of biotechnology and its applications in Islamic countries, as well as endorsing the role played by some Islamic organisations in this field by achieving or developing co-operation between research centres in the Islamic world.

- Enabling Islamic countries that have not yet done so to benefit from the expertise and experience of other countries in devising a national strategy for biotechnology and its applications, and supporting these countries through all possible channels and means and according to the specific conditions and resources of every Islamic country.

- Developing training programmes for scientific manpower specialised in biotechnology and genetic engineering and their applications in the various fields and at the different educational stages and levels, and adopting research and study projects and exchange programmes within and outside the country.

- Creation of database and communication networks on biotechnological activities.

- Achieving balance and complementarity between modern biotechnology and conventional technology in such a way as to ensure the best economic profitability that is compatible with the local conditions and resources of the country.

- Ensuring the optimal utilisation of genetic resources and their exchange among Islamic countries.

- Enlarging the scope of co-operation and co-ordination between relevant Islamic organisations and organs and competent national institutions, particularly in the employment of scientific capacities in the devising and evaluation of strategies.

- Intensifying co-ordination in the supervision of tertiary education students within the framework of joint biotechnological projects financed by the institutions promoting scientific research in Member States.

- Intensifying events and scientific meetings on biotechnology throughout the Islamic world.

Kingdom of Saudi Arabia

Um Al-Qura University proposes the following elements to be incorporated in the Strategy.

1. Define the concept and dimensions of biotechnology and providing the equivalent English and French terms.
2. Define the objectives that the Organisation aspires to fulfil through the preparation of a strategy to consolidate scientific research in this field in the light of past and present considerations, as well as a long-term future vision. This can be achieved through the analysis and study of available facts, conclusions and data.
3. Clarify the importance and relevance of the project for the future.
4. Provide a rich relevant database that would help acquire a clear vision of the present and determine the future repercussion of any decisions that may be taken in this regard.
5. Determine the number and titles of the projects
6. Define biotechnology-related projects.
7. Identify the main and subsidiary requirements for the implementation of each of the study's project in terms of :
    - Human resources (researchers, consulting bodies, experts)
    - Field work requirements (work teams and their methods)
    - Equipment and tools
    - Duration
    - Financial costs

The University of King Abdulaziz pointed out the following elements for possible inlcusion in the Strategy:

1. Conducting of a statistical and analytical study of the various genes that cause lymphatic cancer.
2. Conducting of a statistical and analytical study of the various genes that cause breast cancer.
3. Studying genetic indicators that serve to diagnose hereditary patterns of high cholesterol levels in cardiovascular diseases.
4. Studying the various genes that cause thromboses.
5. Conducting an analytical study of chromosomes using comparative genome modification in pregnant women prone to multiple miscarriages.
6. Conducting an analytical study of chromosomes in babies born with congenital malformations

King Faysal University suggests the following:

1. Specifying the governing principles and the requirements that ought to be taken into account including the genuine Islamic approach, the ethics of scientific research, the available resources, the competition and the transfer and development of technology.
2. Identifying the general objectives of the Strategy which should cover the following: Strengthening technical capabilities of the Muslim countries and sharpening their competitive edge; training researchers in the new fields; promoting scientific cooperation among researchers in the new fields; diversifying income sources in the Muslim world; harnessing science and technology for preservation of environment and sustainable utilization of resources.
3. Setting priorities in biotechnology research
4. Setting up a funding mechanism
5. Establishing a mechanism for processing of research findings

King Fahd University for OIL and Mines suggests the following:

1. Health research: therapy, vaccines, diagnosis, genealogy and cloning
2. Agricultural research: genetic improvement to cure hereditary diseases, upgrade crop volume, save costs and enhance production.
3. Industrial research: protein and enzyme engineering to modify or produce novel proteins with new characteristics to be used as stimulators in such industrial operation as oil refinery, chemicals, fibers and drugs production.

Republic of the Sudan

Agricultural Studies Foundation

Proposals for Consolidating Biotechnology in Islamic Countries

Vision :

To enable the Islamic world to achieve self-reliance in the development and use of biotechnology in all fields and to contribute to the development of the Islamic world.

Strategic objectives :

1. Developing human and financial capacities in biotechnology sciences.
2. Linking Islamic countries with each other in the fields of research, studies, expertise, information and biotechnology-related matters, and linking the Islamic world with the rest of the world.
3. Unifying the Islamic perception of the production and use of biotechnology.
4. Sensitising the Muslim society about the definition of biotechnology, its applications, benefits and dangers from a perspective that takes into consideration the ethical aspects of this technology.
5. Defining the priorities scheduled in the axes of biotechnology and that entail the use of modecular indicators, disease diagnosis, genetic engineering and genomics.
6. Establishing a mediation role for the Islamic world in matters of copyright and other arbitration fields at the international level
7. Co-ordinating among Islamic countries in the field of the legislation governing biosafety (genetically modified organisms and disposal of toxic waste), and preserving biodiversity.
8. Endeavouring to develop the sector of biotechnology in the Islamic countries that lag behind in development to enable them to keep pace with other Islamic countries.
9. Granting priority to the development of a biotechnology that facilitate the achievement of food security in the Islamic world.
10. Encouraging the private sector through incentives to access the field of biotechnology.

Some means of achieving the objectives of the strategy:

1. Creation of a centre or centres dedicated to the development of biotechnology in Islamic countries through research, training, technical consultations, co-ordination, legislation, commission and creation of specialised excellence centres.
2. Devising of mechanisms to finance the various activities of biotechnology.
3. Creation and development of laboratories, equipment and tools necessary for the progress of biotechnology
4. Creation of a database for exchange information on biotechnology among Islamic countries.
5. Devising of joint research projects.
6. Compilation of a legal reference background to support legislation on biological safety in Islamic countries.
7. Introduction of biotechnology sciences in educational curricula at various stages.

8. Drawing of benefits from Islamic ties in and outside the Islamic world to develop biotechnology and co-ordinate with international organisations.

Sultanate of Oman

Sultan Qaboos University

College of Agriculture and Marine Sciences

1. BIOTECHNOLOGY STRATEGY

By definition, biotechnology includes:

- Cell cultures, tissue cultures and organ cultures (plants and animals)
- Recombinant DNA techniques for microbes, plants and animals (cloning, sequencing, genomics, genetic mapping, molecular evolution, diagnostics)
- Somatic fusions and hybridomas (somatic hybrids in plants, monoclonal antibodies)
- Bioreactors and industrial applications

As a strategy, we must develop infrastructure and human resource capability to engage into basic and applied aspects of biotechnology. Ideally, we should be self-sufficient in both, which is not the case. It requires global interaction for exchange of information and materials. We must create system and allow flexibility needed for global interactions. Also, we must prioritise our approaches to biotechnology i.e. should we focus on basic research or ots applications. While we should have a reasonable strength in basic research, our emphasis should be on applications aimed at solving local problems. Some of the examples of biotechnology application at the college of agriculture include:

- Micropropagation of datepalm
- Somatic hybridization for resistance to witches' broom disease of lime
- Molecular mapping of alfalfa witches' broom disease

As an organization, we have the laboratory facilities and human capability to undertake the above noted applications. We have also established successful collaborations to facilitate the work under consideration.

Within Arabic countries, we have been participating in all biotechnology related events. We are also capable of developing collaborations with institutions in the region.

2. MARINE BIOTECHNOLOGY RESEARCH

The sultanate of Oman has been blessed with great variety of coastal habitats that are home to an even greater diversity of animal and plant life. Compared to terrestrial habitats, the oceans and their life forms remains largely unexplored and undoubtedly, they harbor the final storehouse of the Globe's genetic resources. Using the tools of biotechnology, this warehouse can be tapped to provide of range of new products of corporate interest. In contrast to the highly sophisticated level of development that medical biotechnology has attained, marine biotechnology is little more than 20 years old. Because of its scientific youth, the field promises considerable rewards from the discovery of promising new diagnostic and therapeutic agents for disease, including HIV, cancer, Alzheimers disease

and many others, through to the development of new enzyme catalysts and discovery of microorganisms that are able to detoxify and renew pollution-degraded environments. Already, global industry has incorporated R&D findings from marine biotechnologies into food production, pharmaceuticals, biomaterials and has used the marine environments as a source of traditional minerals and as a novel arena in which to create new sources of energy.

Because of the high level of scientific and technical integration required, marine biotechnology represents one of the supreme frontiers left for scientific exploration and commercialisation in the 21st century.

State of Palestine

3. TOWARDS BIOTECHNOLOGY RESEARCH AND INDUSTRY IN PALESTINE

Broadly defined, biotechnology is an industry that uses the new tools of molecular biology and biochemistry to create products, processes useful to mankind. Biotechnology researchers are discovering new medicines and diagnostics, hardier crops, enzymes for industrial uses, and more efficient ways to detect and cleanup pollution.

For the past three decades, biotechnology has been a topic of discussion by medical journals, commercial analysts and the popular media, all examining the potential of the industry to save lives, conserve natural resources, generate thousands of new jobs, and propel technologically-oriented state and nations toward long term prosperity.

The continued expansion of any country emerging biotechnology industry, however is not guaranteed. Other technology centers across and around the world have recognized the growth potential of this industry and are developing innovative private public partnerships, involving industry, government and education to increase the presence of industry in their regions.

In agriculture, biotechnology on the farms employs the results of several scientific disciplines; agronomy, biochemistry, botany, genetics, soil science and others. The application of biotechnology science has rapidly integrated science with the everyday practically of growing crops and raising animals for food and fiber.

The earth's environmental needs in the next millennium will certainly be one of the industry's great challenges. For the first time, humanity has the capability to both threaten the global environment and manage it beneficially. Biotechnology is already being used to clean up oil and chemical spills, and conserve natural environments through increasing public awareness of the need for biodiversity.

In the sea and on the shore, marine biotechnology is another biotechnology strength that is providing significant advancements in biomaterials, health care diagnostics, nutraceuticals, new polymers and biofilms and corrosion science.

In human drugs and therapies, the Middle East diverse population offers ideal conditions for epidemiological studies at several fronts. Pathology, genetics and infectious diseases and therapeutics will facilitate adoption of biotechnology research and industry.

Palestine, as others states, should seek to diversify and strengthen its economic base through the growth of technological industries, including biotechnology. With its natural human resources, biodiversity, quality research centers, and strategic position in the middle East, Palestine has the potential for a dynamic biotechnology industry.

Recognizing this potential a partnership including the government, Palestinian Business, economic development centers, research institution, universities and NGOes should develop a cohesive plan for growth of this industry. It was the consensus of the partnership that such a plan would enable a strategic planning process for long-term industry growth. For this, representatives from each industry stakeholder group should convene for a series of meetings to formulate an industry-based biotechnology competitiveness strategy. Consultancy from expert and funding should be provided in carrying on the development of the competitiveness strategy.

Biotechnology in Palestine :

Representative from industry, higher education, and government should be gathered to begin the formulation of an industry-based biotechnology competitiveness strategy aimed at nucleating and increasing the size and diversity of biotechnology in industry.

The following questions should be posed :

- What products and/or services must Palestine's biotechnology industry develop to best position itself to be competitive on regional basis?
- What legislative and regulatory initiatives can the public sector contribute to assure success of the industry?
- How can state and industry marketing resources be utilized to promote those products and/or services and improve market penetration globally?

The focus groups should address these questions by first identifying perceptions of the strengths and challenges in the areas of capital and finance, education and training, technology transfer, space needs, and public policy and business climate. In addition, the groups offered their perceptions of opportunities and threats facing future development.

The strategic priorities listed below highlight broad categories for discussions, and improvements needed to nucleate biotechnology research

b. Strategy One : Encourage entrepreneurship

Objective: Create venture capital targeted for the biotechnology sector and increase the number of Palestine-based venture capital funding sources, including banks, private placement, retirement funds, and other institutional investors.

c. Strategy Two: Public sector initiatives

Objective: Develop and implement a state tax structure that provides incentives for high biotechnology research and product development companies, and create an effective regulatory structure that minimizes impediments.

d. Strategy Three: Public-Private partnership in technology transfer

Objective: Sustainable strengthen public-private partnerships to increase the number of commercially viable patents emanating from research laboratories at the universities and other research sources located in Palestine.

e. Strategy Four: Develop a biotechnology-age Curriculum

Objective: Establish formal communications mechanisms between the biotechnology research and industry and the country education community to plan for and meet the anticipated needs for employment and training.

The successful implementation of these strategies listed above will :

- Assist government to direct its policies and investments to address the needs and opportunities of the biotechnology research and industry.
- Strengthen higher education's ability to build relationships with industry and government that will develop and grow more knowledgeable citizens and workers and thereby contribute to the economy.
- Help the biotechnology industry identify market needs and demands that require private-public cooperation and establishing an ongoing policy guidance and a review board that assesses progress on the strategy effort.

The Great Socialist People's Libyan Arab Jamahiriya

The Jamahiriya' s assessment of the Project on the Strategy for Development of Biotechnology in the Islamic Countries

Biotechnology has been defined as industrial processes based on biological systems involving naturally-occurring micro organisms, micro organisms that have been modified by genetic engineering or isolated plant and animal cells and the genetic manipulation of cells to produce new strains of plants and animals. Hence the use of various biological processes to make products and perform services can be considered encompassed by Biotechnology. However, at the present time, biotechnology refers, in the new meaning of the word, to the use of the techniques of sciences and engineering for the production of items through biological agents, with view of producing goods that supply the production and service sector in agriculture, industry, medicine and environment.

Broadly speaking, biotechnology refers to any method that modifies the living cell, whether plant, animal or human cells.

The paper pointed out that biotechnology has, indeed, made significant contributions to the industrial and agricultural sectors. In fact, the development, through the use of genetic engineering technology, of several medicines, pharmaceutical products and vaccines gave rise to an industry of which the turnover is estimated at thousands of millions of dollars. Moreover, this also led to the emergence of the art of diagnostics through the Polymer Chain Reaction method (PCR), as an indispensable component in the field of health care; and, without neglecting it, the field of industry.

Remarks:

- A deadline, though approximate, has to be scheduled for the attainment of the objectives of the strategy, for a rigorous implementation of these objectives. Fixing limited deadlines, although approximate, is indispensable for the credibility of the Joint Islamic Actions which are aimed at drawing up a reliable and well-delineated strategy.
- It is necessary that the Islamic Strategy for Biotechnology sets a ground work for fighting the phenomenon of sterility, and the spreading of hereditary diseases which result from social intercourse.
- It is necessary that the Islamic Strategy for Biotechnology involves a plan to benefit from the available possibilities, with view to establishing a list of the medicinal plants in the Islamic World using natural herbs to yield economic profits for each of the member states, and launching joint projects with view to setting into the soil of other Islamic countries some of the plants that do not put into it.
- Ensuring joint Islamic co-operation in investigations, in case of the rapid spreading of epidemic diseases, and in finding facts about unjustified allegations.

- It is necessary that the Islamic Strategy provides for the convening of an annual conference of biologists and the staff working in fields of biotechnology.
- It is necessary (for an Islamic Institution or organisation for Biotechnology) to have an Islamic mechanism which aims at:
  - Advancing the capacities of Islamic states in consenting to investigation, and reducing the effect of the supposed use of biological and toxic weapons, and the outbreak of diseases.
  - Extending the Islamic efforts and reinforcing available mechanisms directed towards controlling, detecting, diagnosing and fighting contagious diseases which impact on human beings, the animals, plants and the environment.
  - Taking part in the international meetings of experts and politicians representing the Islamic states.
  - Directing the training of well experienced scientific executive staff for biological safety purposes.
  - Providing for a broadest exchange, with view to ensuring peaceful use of this technique, and promoting scientific research, with the aim of creating biological defences for the Islamic states.
  - Adopting a concerted Islamic stance likely to propel a large number of states to abide by the international conventions on the spreading of bacteriological and toxin weapons, especially those countries with high biological capacities and who are hostile to the Islamic states.
  - Endorsing unanimous Islamic legislations prohibiting the invention, the production, the accumulation, and the transportation of biological and toxin equipment and elements in the Islamic states.
  - Adopting honourable attitudes vis-à-vis the other states, like the non-aligned states and other countries in line with them, as regards conventions on banning biological weapons on an international level.
  - It is necessary that the strategy adopts a plan for the implementation of policies that draw on co-operation between the Islamic states, with view to establishing modified stem cell banks for agricultural purposes, including some feed crops, grass, halophytes and xerophytes.
  - The strategy should adopt the creation of a fund for shoring up biotechnology.
  - Setting up an Islamic plant for natural drugs industry, which will be the central point for developing this industry, and providing for its financing by the Islamic Development Fund or any similar institution.
  - It is necessary that the strategy adopts a plan to outdo the other states in exploring findings that can be applied from raw materials, like extracting peptides from camels in many of the Islamic states.
  - Adopting a plan to hold a standing fair on biotechnology which will tour the Islamic world on a regular basis, with due attention paid to intellectual property rights, and the protection of inventors from Islamic states.
  - Adopting necessary plans and strategies in the Islamic states for the purpose of encouraging the private sector to engage in biological fields in the Islamic states.

- We underline the assessment, on page 16 of the paper under discussion, of the following risks:
    - Assessing health damages and the risks that result from exposure to radiation, including low-dose exposures.
    - Assessing health risks and the dangers that result from exposure to mutagenic chemicals and cancer-causing toxins.
    - Reducing liability to hereditary genetic mutations.
- Furthermore, we think that the strategy, which provided for the opposite on page 17 in the paper under discussion, should not involve any action that may lead to the use of the nucleic acid in legal medicine to authenticate wine.
- It is necessary to lay down necessary regulations in order to benefit from the centre to be created and which will be specialised in biotechnology, as stipulated in points 6-10, page 18 in the paper under discussion.
- It is possible to avail of the different points of the paper; provided that they are implemented and placed within a binding pattern for all the Islamic states, without distinction and away from hegemony. That will be an opportunity to serve various fields, including social development.
- The necessary introduction of biotechnology sciences in educational curricula in the Islamic states, and reinforcement of the other fields of biological sciences which are already included in these curricula.

Republic of Mali

4. ELEMENTS FOR THE PROMOTION OF BIOTECHNOLOGY

Day after day, biotechnology is becoming an unavoidable development tool for developing countries. To avoid that these countries become reduced to the role of mere consumers of this technology, it is necessary to develop a national strategy for its promotion in our countries.

In Mali, this technology may have several applications and can be of interest to diverse end-users. We suggest the following elements in the event of a national strategy for biotechnology:

1. Definition of application fields and needs for biotechnology

The applications fields of biotechnology include rural development, education, food, health and the monitoring of consumer goods...

Several departments are brought into play : rural development and environment, health, trade, industry and education. Each institution must identify its needs, plan its activities and devise an intervention strategy in co-ordination with the other partners.

2. Review of possibilities and potentialities

Taking into account application needs, it becomes necessary to assess the national possibilities of mastering this technology. It is furthermore necessary to conduct the following investigations :

- Evaluation and definition of the needs in equipment : those available and those necessary;
- Definition of a strategy for developing equipment and infrastructure (complementarity, quest for excellence...);
- Evaluation of the competence of human resources and identification of training needs
- Establishing co-operation ties with centres in the North.

3. Setting up of a regulatory and legislative framework for biosafety

OAU law samples may serve as a basis for African legislation

4. Institutional Measures

States must ensure the a competent authority is created to manage issues related to biotechnology, biosaftey and copyrights

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5. International Co-operation and Financing

Biotechnology must benefit from special attention in the development of scientific exchanges among our countries. A synergy must be fostered with developed countries for a controlled promotion of this tool.

Arab Republic of Egypt

f. National Strategy for Genetic Engineering and Biotechnology

I : Elements of the Strategy

Objectives

The national strategy for genetic engineering and biotechnology aspires to achieve the following objectives :

1- Bringing Egypt into the age of genetic engineering and biotechnology to develop agricultural and industrial production and improve its quality, in such a way as to acquire a competitive edge on the international market, particularly after the full implementation of the GATT agreement.

2- Encouraging the private sector to invest in modern biotechnology-dependent industries.

Priorities

Under the supervision of the Academy for Scientific Research and Technology, a team of twenty scientists from universities and research centres formulated the strategy of genetic engineering and biotechnology in Egypt, and drew up the short-term and long-term action plans for this field, most particularly with regards to the sectors of agriculture, industry, medicine and environment.

The details of the priorities of each plan and each sector are worked out in co-ordination with the Ministry of scientific research and the ministerial commission for sciences and technology.

II : National Commission for Biological Safety

This commission was set up in 1995 and has the following as objectives :

1- Draw up the national policy and regulations that guarantee the safe use of genetic engineering, beings and products.
2- Follow up on the application of biological safety principles.
3- Train and provide consultations on biological safety procedures.

III : Official Authorities Operating in the field of Genetic Engineering and Biotechnology

A- Research and Development Activities

1. Ministry of Scientific Research :
   1.1. Academy of Scientific Research and Technology
   1.2. National Centre for Research
   1.3. Mubarak Complex for Scientific Research and Technological Applications
   1.4. Theodore Bilhars Institute for Research

2. Ministry of Agriculture

2.1. Centre for Agricultural Studies
2.2. Fibre Culture laboratory (project of developing agricultural systems)
2.3. Fibre Culture laboratory at the Centre for Desert Studies
2.4. Laboratory for Research on Veterinary Vaccines

3. Other Parties :
3.1. World Health Organisation
3.2. NAMIRO

B- Academic University Activities:

1. Ain Shams University
2. Al Azhar University
3. American University of Cairo
4. University of Cairo
5. Al Mansoura University
6. Al Manufia University
7. Suez Canal University

C- Activities of Industrial Units

In addition to the laboratories and research and development centres for biotechnology, there are a number of industrial units that form part of the public and private sector and that apply ordinary and advanced biotechnology in their production processes.

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