MEMORIAL LECTURE OF PROF.C.SIVAGNANASUNDRAM -2015

BIOTECHNOLOGY: A SCIENCE FOR HUMAN WELFARE & DEVELOPMENT

By

PROFESSOR V.K.GANESALINGAM

B.Sc.(Hons) (Ceylon); M.Sc.(Hawaii);Ph.D.(London);
Hon.D.Sc. (Sri Lanka).

30th March 2015

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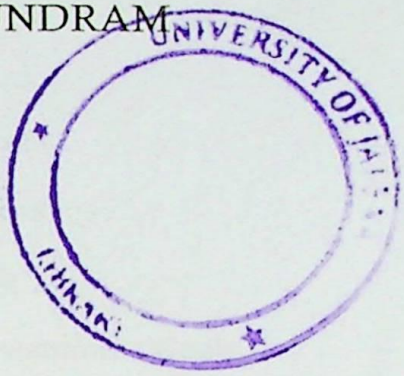

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CONTENTS

Professor Chellathurai Sivagnanasundram Memorial Lecture - 2015

Vice- Chancellor's Message

I am happy to give this message to Prof.C.Sivagnanasundram Memorial Lecture. Prof.C.Sivagnanasundram's dedicated service to this University and society need to be considered as a role model by each and every academic of this University. The ownership and dedication of Prof.C.Sivagnanasundram towards the Department of Community Medicine and Faculty of Medicine, the guidance and support both morally and academically rendered to the faculty staff at all levels cannot be forgotten. My personal association with Prof.C.Sivagnanasundram has given me a lot of moral and academic strength.

This year Prof. V.K.Ganeshaligam a contemporary academic of Prof.C.Sivagnanasundram has come forward to deliver the Memorial Lecture is a unique situation and I would like to thank Prof.C.Ganeshalingam for his willingness. Prof. V. K. Ganeshalingam was the founder Professor of Zoology and is famous for his research in entomology. His services to the University are well known and we are happy to have him for this Memorial Lecture titled 'Biotechnology: A Science for Human welfare and Development'.

Professor (Ms.) V. Arasaratnam
Vice – Chancellor, University of Jaffna.
30.03.2015

BIOTECHNOLOGY: A SCIENCE FOR HUMAN WELFARE AND DEVELOPMENT

Professor V. K.Ganesalingam

01. INTRODUCTION

Progress in biotechnology is a prerequisite for global health, wealth and progress. This is an important ingredient for peace and development in the whole world. Therefore, biotechnology is strongly linked the world together **(Mjøs, 2012)**. Biotechnology is a fast growing field of study all over the world. By this process, both animals and plants can be enhanced for obtaining more food, medical advancement, for the fast growing human population and development and environmental protection. Now, the time is ripe for embodying and integrating this technology more in the future, for the successful development of our economy. We are going to give a general view of this huge episode in detail in a nut shell.

This is the memorial lecture dedicated to late Professor Chellathurai Sivagnanasundram, former Professor and Head of Department of Community Medicine; Dean, Faculty of Medicine and Acting Vice-Chancellor of this University.

02. PROFESSOR CHELLATHURAI SIVAGNANASUNDRAM

My association with Professor Sivagnanasundram (Fig. 01, 1.1, 1.2) is a memorable one; we were appointed lecturers in the University of Peradeniya at the same time, and both of us went at the same time to the United Kingdom for the Ph.D. degree programme. He was in the London School of Tropical Medicine and Hygiene, and I was attached to University College London; both were very close to one another. We met very often and exchanged our views on so many matters, including the world politics, family matters and our educational progress, in the company of (now late) Professor P. Chandrasegaram and Dr. S. Kasinathan (now in Australia). In fact, I remember that all four of us were very friendly, understanding and helpful to one another in a foreign country. I am happy to state that, this group of dedicated academics, all came back to Sri Lanka to serve our people, at that time. None of us stayed there permanently, although some did, even at that time.

Professor Sivagnanasundram, after serving for a while in the University of Peradeniya, under the Headship of Professor Malcom Fernando, accepted the Professorship in the newly created Medical Faculty of the University of Jaffna, adorned by Professor S. Vithiananthan, as its first Vice Chancellor. I should say without hesitation, that Professor Sivagnanasundram and Professor Vithiananthan are the legends of this university.

Fig: 1.1

Laying of the foundation stone for the Faculty of Medicine building on 29.11.1979

Professor Sivagnanasundram, as a specialist in Epidemiology of Malaria, created a area for the sick, elderly and pregnant mothers. Also, he was interested in writing and publishing literary books and articles, especially in Health and social matters. He was also interested in the teachings of Srimath Sathya Sai Baba and disseminated his educational principles in Sri Lanka. So, it was evident that he was attached to the grass root level people, to serve them the best, in teaching, writing, medical field, research, literary writings and religious matters. Particularly, he was indeed a tower of strength to this university for a long period until his untimely demise. Knowledgewise, he was a mobile encyclopedia, of multifarious activities, humanitarian, spiritual and developmental values.

Fig: 1.2

A friendly Prof.C.Sivagnanasundram with his subordinates as the Dean of the Faculty of Medicine, 1988

I was a close associate of him for about fifty years, took part in every celebration of his life, such as birth days, Presidential address of Jaffna Science Association, 60 years of appreciation functions, religious and literary conferences and workshops. As a

result, I have known him very closely and intimately. I feel that, this memorial lecture is the tribute, that I could do for the remembrance of such a devoted, dedicated, educated, unforgettable, ever 'living' in our hearts, humanitarian and leading citizen of science, medicine and literature, in this country.

03. MENDEL AND INHERITANCE OF CHARACTERISTICS

Gregor Johann Mendel (1822-1884) (Fig: 02) was a priest and a scientist, often known as the "father of modern genetics", prior to Watson & Crick (1953).

Fig: 02- Gregor Johann Mendel

Gregor Johann Mendel was interested in inheritance as to how the offspring resembles their parents. He conducted series of experiments on sweet peas, crossing of different characteristics such as, a smooth pea with a wriggled pea. He was lucky in that he happened to pick up discrete characteristics, such as height, which was present to varying degrees. Everybody has height but it varies in a continuous way. Mendel showed that discrete characteristics were inherited from one parent in a measureable way. Many characteristics, however, such as intelligence and beauty are continuous but also hard to measure. The noteworthy feature of Gregor Mendel was that, he was good enough to do such experiments with extreme patience and enormous accuracy, which the present researchers should adopt.

04. BIOTECHNOLOGY CAUSES ADVANCED HEALTH AND PEACE

Biotechnology is essential for peoples' health and peace. Therefore, biotechnology, health, and peace are strongly linked together. Unfortunately, the gap with regard to these, between developing

and industrialized countries appears to continue to increase. It is, therefore, immensely important that the international community becomes active in reducing this gap by promoting science and technology in developing countries. There is a tremendous importance in the genomic revolution to promote health in developing countries and to promote peace with justice in the whole world.

05. THE 2001 UNITED NATIONS MILLENNIUM DEVELOPMENT GOALS (MDG) BY 2015

They are;

1. Eradicate extreme poverty and hunger.
2. Achieve universal primary education.
3. Promote gender equality and empower women.
4. Reduce child mortality.
5. Improve maternal health.
6. Combat HIV/AIDS, malaria, and other diseases.
7. Ensure environmental sustainability.
8. Develop a global partnership for development.

These are indeed excellent ideas to combat poverty and to improve for a way for our development. Our Universities and academics should bring the "bench work" to "development" for progress and prosperity.

06. AN INTERNATIONAL PANEL'S VIEW ON BIOTECHNOLOGY

An international panel (of 28 scientists) view on Biotechnology is interesting and alarming. In this, 28 scientist experts in biotechnology and global health, were asked to answer the following question: "What do you think are the major biotechnologies that can help to improve health in developing countries in the next five to ten years?" The top ten biotechnologists' answers were as follows:

1. Molecular diagnostics
2. Recombinant vaccines
3. Vaccine delivery systems
4. Bio-remediation
5. Sequencing pathogen genomes
6. Female-controlled protection against sexually transmitted diseases
7. Bio-informatics
8. Nutritionally enhanced genetically modified crops
9. Recombinant therapeutic proteins
10. Combinatorial chemistry

The "top ten biotechnologies" fit in well, with the United Nations Millennium Development Goal (MDG) by 2015, said above.

07. HEALTH AS A BRIDGE FOR PEACE (HBP).

Health as a Bridge for Peace (HBP) was formally accepted by the 51st World Health Assembly in May 1998, as a feature of the "Health for all in the 21st Century". Since that time, WHO has worked continuously with the issue of peace-through health. HBP is a multidimensional policy and planning framework which supports health workers in delivering health programmes in conflict and post conflict situations, and at the same time contributes to peace-building. The HBP concept is based on, values derived from 'human rights' and 'humanitarian principles' as well as 'medical ethics'. It is supported by the conviction that it is imperative to adopt 'peace-building strategies' to ensure lasting health gains in the context of social instability and complex emergencies.

08. BIOTECHNOLOGY

Under this background and importance, we will take up Biotechnology, as the use of biological knowledge for better value and welfare to man and his associates, namely plants, animals, microorganisms,

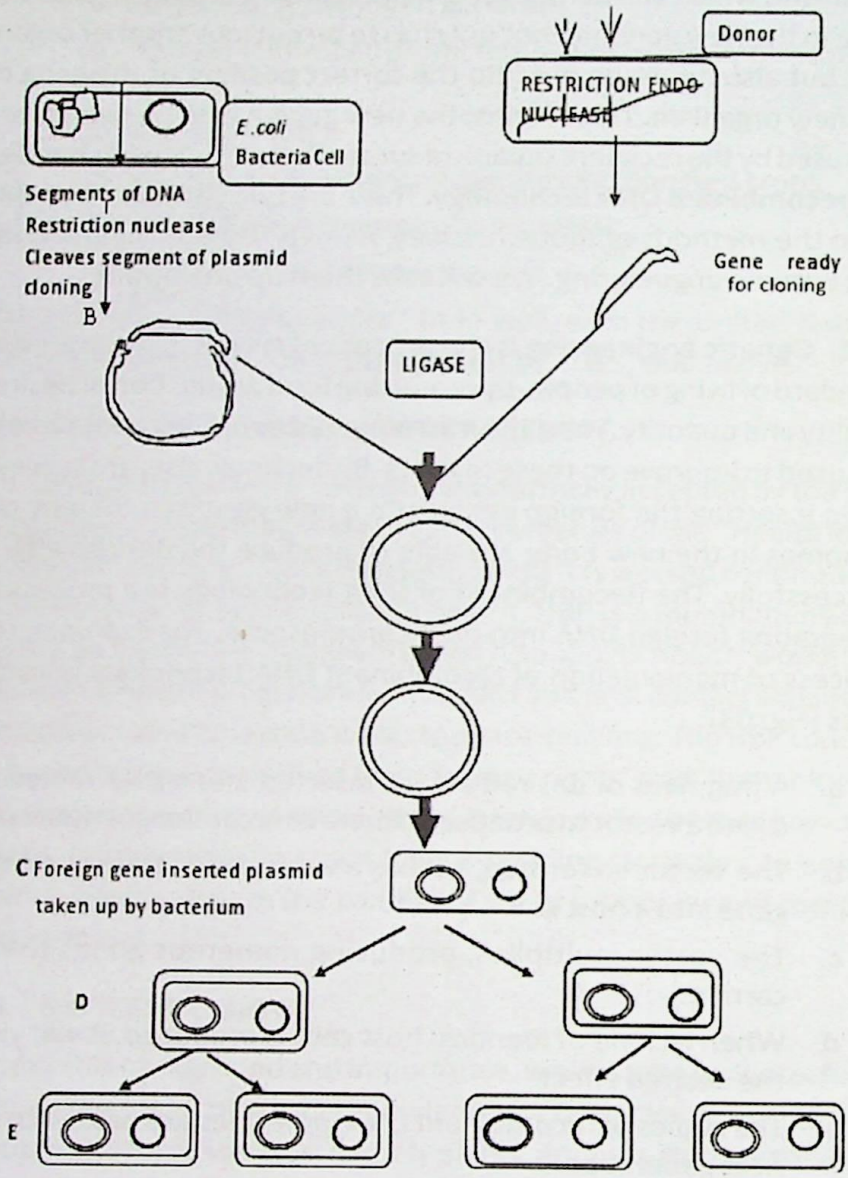
health and environment. In biotechnology we introduce genes into new species to get the advantage of production and enhanced value. This technique is said to be **DNA manipulation.** By biotechnological means, we can introduce a new gene into the genome of another organism, which will be the genome receptor. It is a must, that the gene in the new genome, not only has to be put into another organism, but also has to be put into the correct position of the gene of the new organism. That means, the new gene has to be recognized and used by the recipient organism successfully. This is what is called the **recombinant DNA technology.** There are two particular benefits from the methods of Biotechnology, namely, Genetic engineering and Enzyme engineering. We will take them up one by one.

08.1 Genetic engineering is the process of successfully improving standard of living of people, by producing food production of desired quality and quantity. Thus, the microorganisms or their components are used to improve on these matters. Biotechnologists are successful in inserting the foreign genes into a new genome; thereby the genomes in the new body, are able to produce the desired effects successfully. The Recombinant of DNA technology is a process of integrating foreign DNA into host chromosome. For example, the process of manipulation of recombinant DNA technology is as follows (Fig: 03):

a. A fragment of desired DNA is inserted into a DNA molecule called a vector to produce chimera or recombinant molecule.
b. The vector so formed, acts as a vehicle that transports the gene into a host cell.
c. The vector multiplies, producing numerous genes that it carries.
d. When a clone of identical host cells is produced, it will yield the desired effect.
e. The copies of recombinant DNA molecules are passed to the next generation

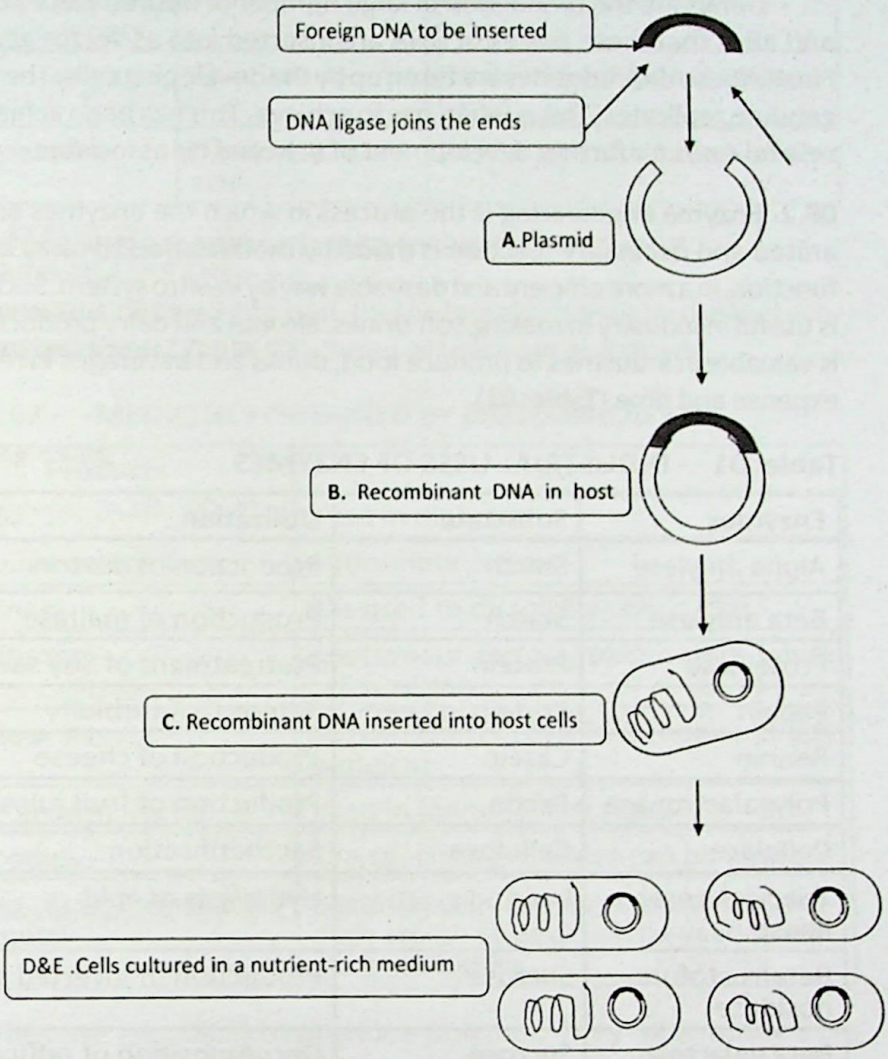
fig: 03 - PATTERN OF PROCESS OF BIOTECHNOLOGY
(Ganesalingam,1999)

Fig: 03 - PATTERN OF PROCESS OF BIOTECHNOLOGY (Ganesalingam,1999)



This also can be explained by introducing a foreign desirable DNA, by Recombinant DNA Technology (Fig: 04).

Fig: 04 - RECOMBINANT DNA TECHNOLOGY (Mannino, 1995)



A bacterial plasmid is used by the same restriction enzyme, to cut out the foreign DNA from its original chromosome. The foreign DNA is then inserted into the bacterial plasmid (A). The recombinant DNA is inserted into a bacterial cell (B&C). The bacterium is grown in a nutrient-rich medium, asexually reproducing identical copies, or clones, of itself (D&E).

Genes are the production of large number of desired pieces of DNA and after that these pieces of DNA are inserted into as vector genome. Finally these desired genes are taken up by the developing cells. The vector genome replicates. This is what, has to achieve. This has been achieved in several cases for further development of man and his associates.

08.2. Enzyme engineering is the process in which the enzymes are separated and necessary reaction is made by modification to carry out the function, in a more efficient and desirable way by in-vitro system. Such work is useful in industry in making soft drinks, alcohol and dairy products. This is valuable in industries to produce food, drinks and beverages in reduced expense and time **(Table: 01).**

Table: 01 - INDUSTRIAL USES OF ENZYMES

Enzymes	Substrate	Utilization
Alpha amylase	Starch	Production of dextrin
Beta amylase	Starch	Production of maltase
Proteinase	Protein	Pretreatment of Soy sauce
Papain	Protein in beer	Removal of turbidity
Rennin	Casein	Production of cheese
Polygalactronase	Pectin	Production of fruit juice
Cellulase	Cellulose	Saccharification
Triacylglycerol lipase	Lipid	Hydrolysis of lipid
Betafructofura-nosidase	Sucrose	Production of inverted sugar
Beta galactosi-dase	Sucrose	Decomposition of raffinose

Apha galactosi-dase	Raffinose	Decomposition of raffinose
Anthocyanase	Antocyan	Decolouration of antocyan glycoside
AMP deaminase	Adenylic acid	Production of inosinic acid
Steroid-11-beta monoxyugenase	Sterol	Production of steroid
Glucose isomer-ase	Glucose	Production of high fructose syrup
Aminoacylase	D,L-acyl amino acid	Production of L-amino acid

09. MEDICINES MANUFACTURED BY BIOTECHNOLOGY

Various medicines are obtained, for the benefit of man by the biotechnological methods **(Table-02).** Some of them are as follows:

Table: 02 - MEDICINES OBTAINED BY BIOTECHNOLOGY

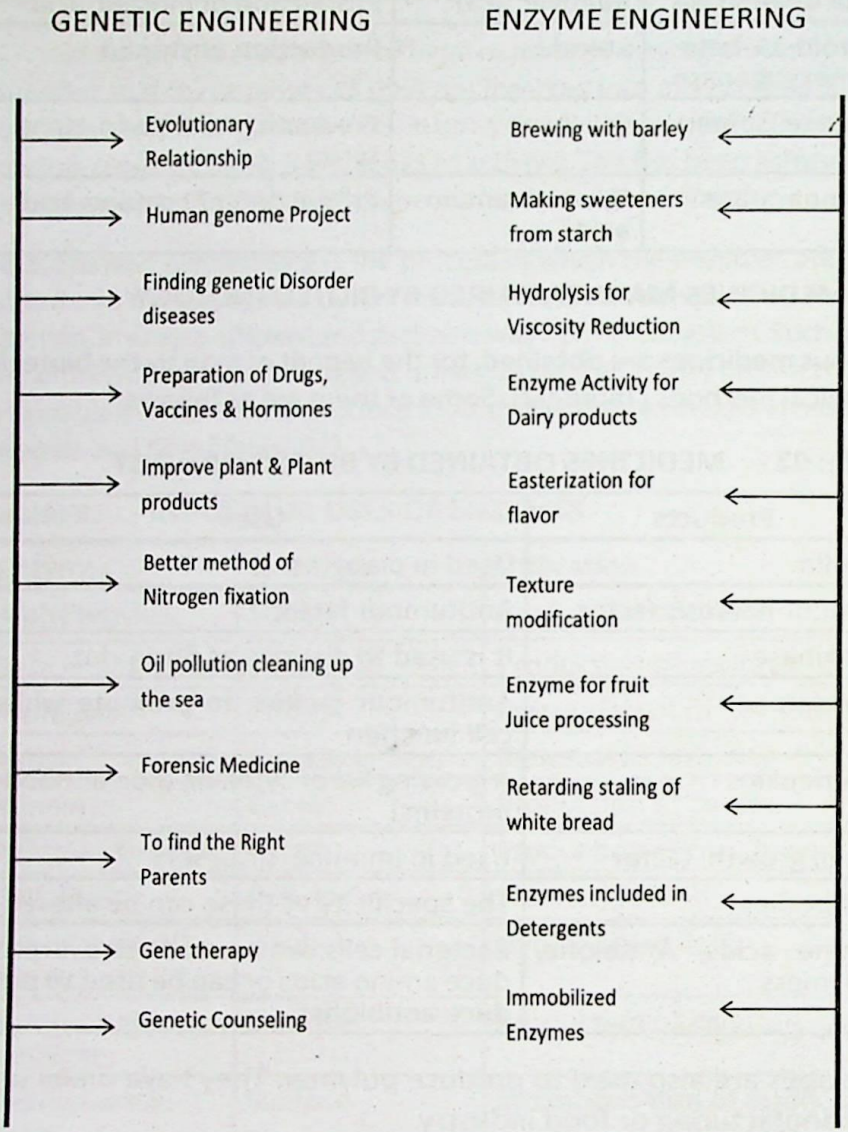
Products	Uses
Insulin	Used in diabetes
Tumour necrosis factor	Antitumour factor
Urokinase	It is used to dissolve as fibrin clot
Interferons	Antitumour factors, to promote white cell function
Interleukins	A growing list of cytokine (non antibody proteins)
B-cell growth factor	Used in immune disorders
Antibodies	The specificity of these can be altered
Amino acids, Antibiotic, Polymers	Bacterial cells can be made to overpro-duce amino acids or can be used to pro-duce antibiotics.

Microbes are also used to produce polymer. They have many uses in manufacturing or food industry.

('Molecular genetics', 1999)

Some of the valuable uses of biotechnology in genetic and enzyme engineering are given below (Fig: 05):

Fig: 05 USES OF BIOTECHNOLOGY



(Ganesalingam, 1999, 2004, 2007)

10. TRANSGENIC ORGANISMS FORMED BY BIOTECHNOLOGY

The animal or plant that has been subjected to transgenes is by insertion of a 'foreign' gene into a genome is said to be **Transgenic organisms.** (Fig: 06). It is the resultant alteration of the phenotype of the host organism. The transgene is passed to generation after generation of the new host.

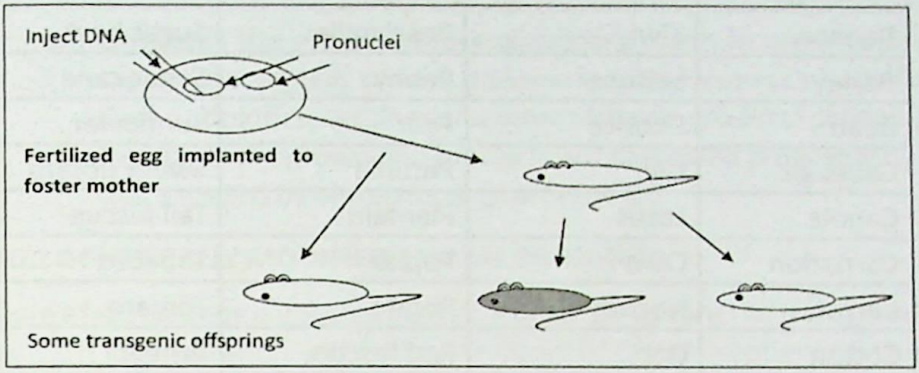


Fig: 06- Method of production of transgenic animal
('Molecular Genetics', 1999)

Some examples of transgenic plants and animals are given below:

10.1 GENETICALLY MODIFIED PLANT PRODUCTS

These are prepared to produce high product and profit from plants (Gasser & Fraley, 1992). People eat genetically modified soya foods, tomatoes, and cereals, without adverse effect. Currently, what we eat, particularly agricultural products such as, potato, green gram, black gram, cereals and several other cereals are grown by modification of genes to protect insect attack, quick growth, and protection from decaying during long time storage (Table:03). In order to produce more plant foods, better crop plants, more profits, better food reserves for the whole world population, plants and beneficial organisms are used biotechnologically, especially when the normal food crops are not enough for the fast growing population.

TABLE: 03 - PLANTS THAT HAVE BEEN GENETICALLY TRANSFORMED

Alfalfa	Cucumber	Orchid	Rye
Apple	Egg plant	Papaya	Sorghum
Arabidopsis	Flax	Pea	Soya bean
Asparagus	Grape	Peanut	Strawberry
Banana	Kiwi	Pearl millet	Sugar beet
Barley	Lettuce	Peony	Sugar cane
Bean	Licorice	Pear	Sunflower
Cabbage	Lily	Petunia	Sweet potato
Canola	Lotus	Plantain	Tall fescue
Carnation	Corn	Poplar	Tobacco
Carrot	Norway spruce	Potato	Tomato
Cotton	Oat	Red fescue	Wheat
Cranberry	Orchid grass	Rice	White spruce

(Glick & Pasternak, 1998)

The following products are some of the good outcome of genetically modified agricultural plants:

1. **Herbicide–resistant plants:** Biotechnology is used in such a way, that spraying would reduce weeds but not the valuable crop plants. Virus attack is reduced by introducing viral protein genes to the plants to protect them from viral infection. In this way virus resistant plants can be produced, which is beneficial to farmers.

2. **Stress-tolerant plants:** The plants are made to tolerate heat, drought and damage by UV; particularly, the resistance variety to damage by drought can be avoided in less rainfall areas, by biotechnological methods.

3. **Insect-resistant plants:** By introducing insecticide producing proteins into the crop plants by biotechnological means, the spray with insecticide is avoided to control insect pests. The

plants will produce the insect killing effects by themselves, because this effect is within the plants, not damaging the plants themselves (Ganesalingam, 1998, 2004, 2007).

4. **Plants products in storage:** By altering the ripening pattern, by lengthening the periods, fruits and foliage can be used after long period without damage or waste, by biotechnological methods.
5. **Quickens the growth:** More plants are made to grow quite rapidly, harvested, stored, and marketed whenever needed. Even antibiotics, vaccines and other valuable products producing plants are grown and products are harvested profitably by quick means by biotechnological method.

10.2 GENETICALLY MODIFIED ANIMAL PRODUCTS

Here a fertilized egg is injected with DNA gene, containing the transgene. By such incorporation within the construct of certain sequences, the transgene is incorporated into new genome. As a result, the final adult body is made to contain the transgene, in every cell. Therefore, such transgene will be able to pass on to its offspring over and over again. It is evident that, in the production of animal transgenesis, the miss rate (the failure) is enormous. Therefore the second way is to use embryonic stem cells. The stem cells are formed during blastocyst stage, shortly after fertilization. The stem cells are cultured and transgene construct added to the multiplying cells. The cultured cells can be tested with PCR (*Polymerase Chain Reaction*) to make sure the results needed produce the transgenic animals of desired quality.

The advantage of transgenic animals:

1. Milk-producing capacity of cattles and goats are made to increase in quantity.
2. Milk produced is made to be of better quality.
3. For serious disease, particularly in blood cancer patients, the diseased cells are removed from the patients, modified and then returned. This is done in 'bone marrow cell

change' by biotechnology treatments.

4. Farm animals such as goat, sheep, fowl or fish are made to produce enormous meat.
5. Fishes are made to live and thrive to large size in lower or higher water temperature.
6. Animals are produced to resist diseases, caused by infection of virus, bacteria, fungi, protozoa and parasites.
7. Physiology of animals are improved for their better physical function and functional capacity.

10.3. TRANSGENIC CATTLE

If a cattle can produce approximately 10,000 liters of milk, containing about 35 grams of protein per litre, it is the ideal candidate for transgenesis. By using similar experimental strategies, transgenic versions of cattles, sheep, goats, pigs, birds and fishes have been generated (Glick & Pasternak, 1988).

The transgenic cattle can be derived by the following steps:

1. Collecting the oocytes from killed cows in slaughter house
2. In vitro maturation of oocytes
3. In vitro fertilization with good bull semen
4. Centrifugation of fertilized eggs to concentrate the yolk
5. Microinjection of input DNA into male pronuclei
6. In vitro development of embryos
7. Non-surgical implantation of one embryo into a recipient foster mother
8. DNA screening of the offspring for the presence of the transgene

10.4. GM 'HUMAN MILK' FROM COWS

It is hoped that this process can lead to get "human milk" from cows, sheep and goats. Cows have been genetically modified to produce

"human milk". The human genes were introduced to a herd of 300 cows by Chinese scientists to provide an alternative to human breast milk. The researchers are confident that the milk from ordinary cows would be as safe as "human milk". "Within ten years, people will be able to pick up these products at the supermarket", so said Prof.Ning Li, the Director of China Agricultural University. The researchers say that they used cloning technology to introduce human gene into the DNA of dairy cows before the genetically modified embryos were implanted into the surrogate cows. The modified bovine milk is a possible substitute for human milk.

11. VACCINES PREPARED BY BIOTECHNOLOGY

Vaccines protect a recipient from pathogenic agents by establishing an immunatized resistance to infection. The infectious agents are inactivated, neutralized and killed; as such its proliferation is prevented and the disease status is not established. With the preparation of vaccines, several epidemic diseases have been brought under control. However, occasionally, the protective measures become ineffective, and devastating, that new out breaks of diseases occur. For many animal and human diseases there have been no vaccines but now, it is possible.

It is obvious that vaccine programmes are essential for global health. Development of new and efficient vaccines is dependent on modern biotechnology. As early as 1988, the World Health Assembly passed a resolution to eradicate poliomyelitis by the year 2000. By the turn of the 21st century, they have nearly reached this goal as expected by this means.

Within the last decade, success has been achieved by recombinant DNA technology to provide a new generation of vaccines that overcome the draw backs of traditional vaccines. The availability of gene cloning has enabled researches to contemplate various novel strategies for vaccine development. The DNA Recombinant vaccines are being developed for most of the infectious diseases (Table: 04).

Table:- 04 DNA Recombinant vaccines that are currently being developed against human disease organisms.

Pathogenic agent	Diseases
VIRUS	
Varicella-zoster virus	Chicken pox
Cytomegalo virus	Infection in infants & immunocompromised patients
Dengue virus	Haemorrhagic fever
Hepatitis A virus	High fever, liver damage
Hepatitis B virus	Long- term liver damage
Herpes simplex virus type 2	Genital ulcers
Influenza A and B viruses	Acute respiratory disease
Japanese encephalitis virus	Encephalitis
Para influenza virus	Inflammation of the upper respiratory tract
Rabies virus	Encephalitis
Respiratory syncytial virus	Upper and lower respiratory tract lesions
Rotavirus	Acute infantile gastroenteritis
Yellow fever virus	Lesions of heart, kidney and liver
Human immuno deficiency virus	AIDS
BACTERIA	
Vibrio cholera	Cholera
E.coli enterotoxinstrains	Diarrheal disease
Neisseria gonorrhoeae	Gonorrhea
Haemophilis influenza	Meningitis, septicemic conditions
Mycobacterium leprae	Leprosy
Neisseria meningitides	Meningitis
Bordetella pertussis	Whooping cough

Shigella strains	Dysentery
Streptococcus group A	Scarlet fever, rheumatic fever, throat infection
Streptococcus group B	Sepsis, urogenital tract infection
Streptococcus pneumoniae	Pneumonia, meningitis
Clostridium tetanus	Tetanus
Mycobacterium tuberculosis	Tuberculosis
Salmonella typhi	Typhoid fever
PARASITES	
Onchocera volvulus	River blindness
Leishmania spp.	Internal and external lesions
Plasmodium spp.	Malaria
Schistosoma manoni	Schistosomiasis
Trypanosoma spp.	Sleeping sickness
Wuchereria bancrofti	Filaria

(Glick & Pasternak,1998)

12. ENVIRONMENTAL PROTECTION BY BIOTECHNOLOGY

Accumulation of refuse from industries, agriculture, personal and domestic wastes is of much concern, because of their environmental hazards for ill health, diseases and deaths. The answer for this lies in two aspects; first is how to dispose the ever increasing quantity of wastes; the second is how to remove the toxic compounds from the wastes.

Bio-remediation is the process of using biologic agents to remove the toxic materials from the environmental wastes. With the discovery of a number of soil microorganisms, it was found that degradation of such toxic materials was possible, by making use of such microorganisms. Biochemical assays have shown that various *Pseudomonas* strains of bacteria can break down and detoxify more than 100 different organic compounds (Glick & Pasternak, 1998).The bio-degradation requires concerted efforts of several different enzymes. The genes that code for the

enzymes for these bio-degradation pathways are sometimes located in the chromosomal DNA of the microorganisms. In some organisms, the genes that contribute to the de-gradate pathways are found on both chromosomal and plasmid DNA. Although, many naturally occurring microorganisms degrade into number of different foreign chemicals, there are limitations to the biological treatment of these waste materials. One way to solve some of these problems is, to transfer by conjugation into recipient strain plasmids that carry gene containing the DNA, for the degenerative pathways of the toxic chemicals. Bio-remediation is also possible by using bacteria which can clean up environmental contamination, such as oil spills, specially produced by damaged ships and containers by accident or otherwise.

13. THERAPEUTIC PROCESS BY BIOTECHNOLOGY

Therapeutic process is the treatment of disease or other disorders by the skilled physical therapy. Biotechnology based therapeutic agents are derived for several diseases. Particularly, the recombinant blood products, cytokinese, monoclonal antibodies, tissue engineered products such as bone grafts, of foreign body, and collagen agents are used as therapeutic components for certain diseases. Replacement of heart valves is carried out by therapeutic technology, for a better acceptance by the body concerned.

14. GENE THERAPY

Like what was done to animals and plants, by inserting genes to new animal or plant genome, it is possible to do the same technology for human too, in order to cure some diseases (Anderson, 1992, 1999). There are several human diseases (Ganesalingam, 2010), and some of which are caused by defective genes. If the potential and correct genes are inserted into the human genome in the right tissues, the disease can be corrected in the human genome cell. Such transgenic features are inherited to the succeeding generations. This can be done in the somatic cells, but cannot be done in the germ cells.

Therefore, gene therapy is defined as the delivery of an effective gene into an individual with the aim of permanently correcting or curing a

genetic disease, caused by a defective gene. The steps for gene therapy are as follows:

a. The 'desirable' gene has to be isolated from the 'donor' by good laboratory work.
b. The gene has to be introduced meticulously into the organ/ tissue gene of the patient.
c. The gene has to be made to express itself in the correct place (loci) of tissue gene for functioning effectively.
d. Integration of the transgene and its expression need to be stable in the recipient.
e. The gene therapy mechanism is very expensive, needs lot of hard work and guidance of high caliber of intelligence, laboratory and technical work.

Methods of achieving the insertion of new DNA are by "Vectors". Viruses are commonly used as vectors. They hijack the DNA replicating machinery inside the cells and used them to make copies themselves. Thus, it is possible to programme the virus to deliver new modified genes at the right place, where they are needed.

Some of the somatic gene therapy in practice is as follows (Table: 05):

Table: 05 - Gene products used in Gene therapy

Disease	Gene product
Cysticfibrosis	Cystic fibrosis transmembrane regulator
Chronic granulomatous disease	NADPH oxidize components
Haemophilia B	Blood factor IX
Hyperecholesterolaemia	LDI receptor
Duchenne muscular dystrophy	Dystrophin
Severe combined immunodeficiency (SCID)	Adenosine deaminase

(Anderson, 1992, 1999)

15. CLONING

Cloning is a process of formation of a population of cells or organisms that is genetically identical as a result of asexual reproduction, breeding of pure breed (isogenic) organisms, or forming genetically identical organisms by nuclear transplantation. Particularly, nuclear transplantation in somatic cell is becoming a popular method in producing viable individuals by asexual reproduction.

Using this technique, the first mammal, "Dolly", the sheep, which was cloned in 1977, carried out by Ian Wilmut and his colleagues (Wilmut *et al*, 1997), by making use of technique of somatic cell nucleus transfer. In this, all the DNA are removed from a fertilized egg and replaced it with that from the nucleus DNA of another cell. This "new" egg was then implanted into a foster mother and a new lamb was born. This lamb "Dolly" was original adult animal, used as a source of DNA transfer. Dolly produced an offspring named, "Polly". Since then, other animals have been successfully cloned from cultured differentiated adult cells. In other words individual will be formed without sexual contact between male and female.

There was another study made in the University of Hawaii, that a large group of mice was produced by cloning. This work shows that cloning of animals is possible. It is good to produce as large number of animals to obtain valuable animal products for the use of human population.

Moreover, molecular biology of human development has rapidly advanced in the field of embryology of animals in recent times. These techniques are widely used in laboratories, to the genetic regulation of morphogenesis. In this study the scientists come to know how cells are committed to form various parts in the embryo. The embryologists are beginning to understand how, when and where selected genes are activated and expressed in the embryo during normal and abnormal developments. This is also helpful in biotechnological manipulation.

Interest in human cloning has generated considerable debate because of social, ethical and legal implications that may occur due to this. If human cloning is done, lot of social problems and confusion might crop

up. However experiments are being done in some countries, illegally and very confidentially. It is immoral and against the scientific principle, if the Biotechnologists involve in human cloning, because it may create confusion among people and would cause inhumanity and social problems. Therefore using human as a subject for cloning is prohibited in the whole world. However, the isolation and programmed culture of human embryonic stem cells hold great potential for treatment of degeneration, malignancy and genetic diseases. Stem cells are the cells of the embryonic stage for developing into respective parts of the animal concerned. This is a solution for those who are born with birth defects and serious diseases.

16. STEM CELL RESEARCH IN BIOTECHNOLOGY

Stem cell is an unspecialized cell that gives rise to differentiated cells by biotechnological means. This is interesting because, Scientists are able to replace worn out or damaged cells in diseases, trauma, aging and cancer disease (Ganesalingam, 2013).

Researchers have successfully programmed the adult cells within a living animal for the first time, creating stem cells that have the ability to grow into any tissue found inside the body. (This is published in "Nature" journal, 2013). It is believed that it would take at least five years before the first clinical trial is programmed in adult cells within the human patient.

Progress is underway towards immune based cancer treatment, by programming the stem cells biotechnology. In this process, it was to get T cells (immune system) to the target cancer cells, ignoring healthy cells. Researchers use this technique to suppress tumour growth in mice.

Schizophrena is a severe mental disorder or disintegration of process of thinking. In a research study in rat on this disease, shows that transplanting stem cells into rat brain, in the centra, the hippoc ampus in the brain, restored the functions that are abnormal in Schizophrena. "Since these cells are not functioning properly, our idea is to replace them", said the study leader, Prof.Lodge, of the University of Texus, San Antonia, USA.

The stem cells are used to form the world's first "test tube burger" (like "hamburger" sandwich that we eat). This is prepared from the laboratory grown meat by biotechnology. This was carried out by Prof. Mark Post from the University of Maastricht, the Netherlands. In this process, a simple muscle tissue is taken from a cow; the stem cells are isolated and multiplied using growth promotors and chemicals in a petri dish. The "test tube burger", thus prepared, resembles the real hamburger in taste and contents. It will be in market very soon. This was released in London in last August 2013.

Stem cells were used to grow "Brain in bottles", by genetic engineering technology. This is done by artificially "progrmming" the skin cells, by inducing pluripotent stem cells. This was published in "Nature" journal (2013). It forms an entire organoid, showing the development of a brain (a "miniature brain") (Fig: 07). This can be used for research purpose and for testing drugs, but not for transplant. Anyway, it was possible to produce a 'mini brain' by biotechnological means. This research was carried out by a British and Austrian team, led by Prof. Jeurgen Knoblish of the Institute of Molecular Biotechnology, Vienna. "You can study the car parts but you can't drive it", so said the team leader.

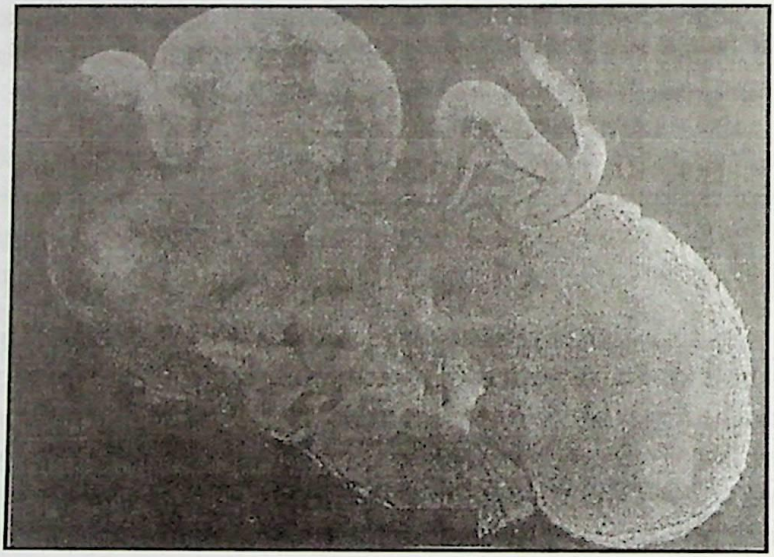


Fig: 07 -"Mini Brain" grown by research

17. ETHICS IN BIOTECHNOLOGY

Ethics are a system of moral principles of good behaviour, following a code of moral principles derived from a system of values and believes. In scientific research, also these principles are adhered to.

But, the public is under the impression that the "scientists" are making a world of their own; in the sense, they create new things and change animals, plants and microorganisms for their whims and fancies. It is not so. These scientific improvements are done for more productions from animals, plants and microorganisms for the benefit of the people, for them to live comfortably, conveniently and economically, in the rapid increasing population, economic disasters and poor livelihood. Under the circumstances, advancing biotechnological innovations is the only answer. In fact, the scientists do honour the principles of ethics in their research in Biotechnology, Genotherapy, Cloning and Stem cell research, and will not deviate from the ethical principles, which they follow strictly, all over the world.

18. FEAR AMONG THE PUBLIC ON BIOTECHNOLOGY

People continue to worry about the dangers of recombinant DNA work. The worry is probably is of two kinds.

First is, whether the GM food is safe to eat. The scientists assess the chemical and nutritional composition of the GM food to find out whether or not, there is any potential production of toxin or allergic substances in the GM food. Again, the GM foods are assessed for any potential risk to human health through environmental exposure. If all the health factors are proved to be safe only, the GM foods are approved for sale in the market. Almost all the developing countries and developed countries have accepted this GM food.

Second is, there is a concern among some people that, the toxic genes may 'escape' from the industrial or experimental laboratories to outside and cause harm to the public, if infected directly or indirectly the human being. For this matter, strict containment in the laboratory

with physical and biological barriers is necessary. However, they are incapable of successful reproduction outside the laboratory, even if they "escape" from the working environment.

In fact, this matter has created a conflict between academic freedom and industrial secrecy. It seems that recombinant DNA technology is very lucrative practice economically, especially in agricultural, pharmaceuticals and food industries. This shows that the academic endeavours are done presumably openly with free exchange of information among their colleagues; whereas private enterprise organizations involve in some degree of secrecy for their own trade promotion (Tamarin,1996).

Whatever it is, the scientists are concerned over the new innovations, new economic persuits and new and safe avenues for the people's future welfare, health and development.

19. CONCLUSION

Genetics is the study of ways by which the hereditary characteristics are passed from generation to generation. Biotechnology is the manipulation of the genes by introducing a gene of a desired characteristic into a genome, to obtain economically productive individuals. Such transgenic technology was subjected to plants, animals and microorganisms, to obtain the desired effects in agricultural products, animal husbandry, industrial development and solving some serious diseases. Thus, this process gives richness and genotherapic values. The research on this field is being done without deviating from the ethical principles. But the progress of this study is not effective, due to lack of working facilities, qualified personals and fund for research. If more research takes place in various fields, namely in science, medicine, agriculture and veterinary science, biochemistry and biological sciences, the resulting economic benefits and development in Sri Lanka would be enormous. This is important for the development of Sri Lankan's economy at present juncture (Ganesalingam, 2012), especially, when development is much concerned at present in Sri Lanka and elsewhere in the world.

20. ACKNOWLEDGEMENTS

I thank every one of you for attending this memorial talk, presented for remembering late Professor C. Sivagnanasundram, who was one of the important pillars of this university. I thank the Faculty of Medicine, University of Jaffna for giving me an opportunity for expressing my views on the favourable subject of mine. I am grateful to **Professor (Miss) V. Arasaratnam**, the Vice Chancellor, **Dr. S. Balakumar**, the Dean/ Medical Faculty, and **Dr.N.Sivarajah** of the University of Jaffna, for their keen interest in this subject and helping me in this matter. I deeply indebted to **Professor K. Balasubramaniam** (Former Professor of Biochemistry, University of Jaffna) for his enormous contribution to the field of Biotechnology in this University.

I thank **Mr.R.Sharveswara** Assistant Registrar of Faculty of Medicine and **Mr.N.Thileepan, and Assistant Registrar & Staff of the academic branch** for their enormous assistance. I also thank **Mrs.M.Sapanathan** for helping me in this talk today.

Finally, I thank profusely everyone present here and everyone concerned, especially University academic staff, academic support staff, friends, well wishers, the principals, teachers, students and Professor Sivagnanasundram's family, his friends and relatives, in making this event a success.

Thank you all.

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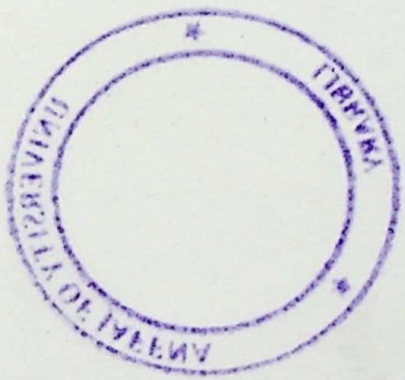

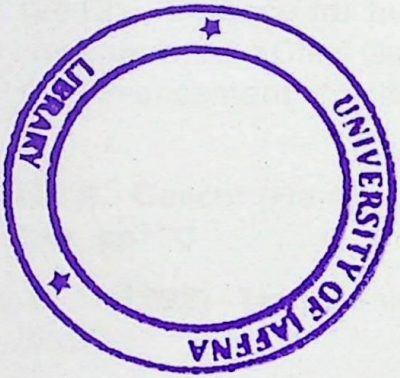
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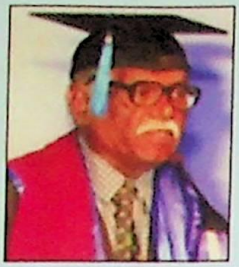

PROFESSOR V.K. GANESALINGAM

(Emeritus Professor)

He was appointed the Founder Professor of Zoology in the University of Jaffna, Sri Lankan in 1975. He served as the Dean, Faculty of Science in 1988 -1991, Acting Vice Chancellor in 1988. Again he was elected as the Dean, Faculty of Science in 1996 and completed in 1999.

He earned his B.Sc. (Honours in Zoology) from the University of Ceylon, Colombo in 1962 and M.Sc. in Entomology from the University of Hawaii, USA as a scholar in 1965. He was awarded Ph.D. (London) for his research work carried out in the University College London (University of London) in 1970. The University of Jaffna awarded him the degree of D.Sc. (Honoris Causa) in 2003.

He was a Demonstrator in the University of Ceylon, Colombo in 1962-1963; Assistant Lecturer in University of Peradeniya in 1965-1970, Lecturer in 1970-1975; Professor in the University of Jaffna 1975-2001; and Resident Consultant, Faculty of Science in the South Eastern University of Sri Lanka 2001-2005. He is a Faculty Board member in the Faculty of Postgraduate studies, Chief Inquiry officer and a Visiting Professor in the University of Jaffna. He was a recipient of Fellowship of East West Centre, USA (1963-65), Commonwealth Universities Association Fellowship (1978-79), Nuffield Commonwealth Fellowship (1986-87), GTZ Fellowship (1986) and British Council Fellowship (1990).He published several research papers, articles and books.

He was the President of the Sri Lanka Red Cross Society, Jaffna Branch for about 20 years, Vice President in the Sri Lanka Red Cross (whole island) in 2002-2005, President in the Family Planning Association of Sri Lanka, Jaffna branch; Deputy District Governor - Lions Clubs International; President, Jaffna District Consumers' Society; President Jaffna science association and President of NGO consortium (Jaffna). He is the Justice of the Peace (Whole Island).

He hails from Puloly centre, Point Pedro. His wife a retired teacher and a pensioner in government service and two sons, a University Senior Lecturer and a Consultant Neurosurgeon respectively are in the UK.

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