Genetics and Biotechnology for human survival

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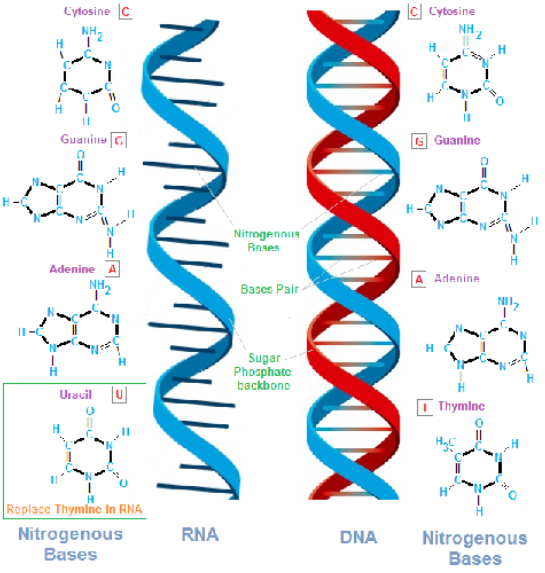
The science of Genetics dealing with evolutionary relationship of living things has a history of over several centuries. The attempts to discover the reason why a horse always gives birth to a foal, and infants bear similar features to their parents *etc.* have been confirmed from such times. From about 6000 years ago man has domesticated animals and cultivated crops such as rice. He has produced and continued to maintain successful generations which are more advanced by hybridization with more advanced varieties. However the laws of inheritance were defined for the first time after the discoveries of Gregor Mendel in 1866. Through researches he carried out during the years 1858 to 1865, he showed how the characters of pea plants are carried out to future generations. Also it was found that certain characters are expressed as dominant and others as recessive, according to simple statistical laws. The patterns of expression of these characters are called Mendel's Laws of Inheritance.

In recent times more complex patterns of inheritances based on Mendel's simple laws have been put forward. Gene technology is not an unfamiliar word in view of the new discoveries by man who is moving towards a technological revolution day by day. It is a technology based on nucleic acid, of the living being, which are the foundations of life. Therefore biotechnology is the manufacture of new products using living organism and living systems. Or it is the use of technology to manufacture new products by genetically changing living systems and organism. In the living systems there are two types of nucleic acid. They are deoxyribonucleic (DNA) and ribonucleic acid. (RNA) In living cells the inherited information is stored in DNA which is present in 46 chromosomes (in humans). Man is made up of approximately 3x1013 such cells. The building units

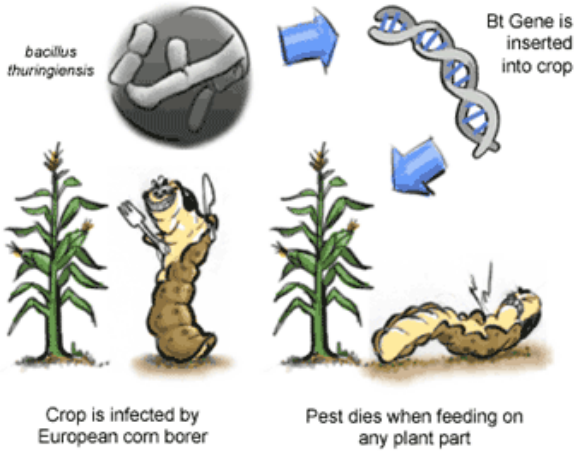


of nucleic acid are nucleotides. Nucleotides are made up of a nitrogenous base, a pentose sugar and a phosphate group combined together. The gene which is the functional unit of the genome exits as two nucleotide chains. Thousands of such genes provide the codes for the production of proteins.

Special Features of DNA

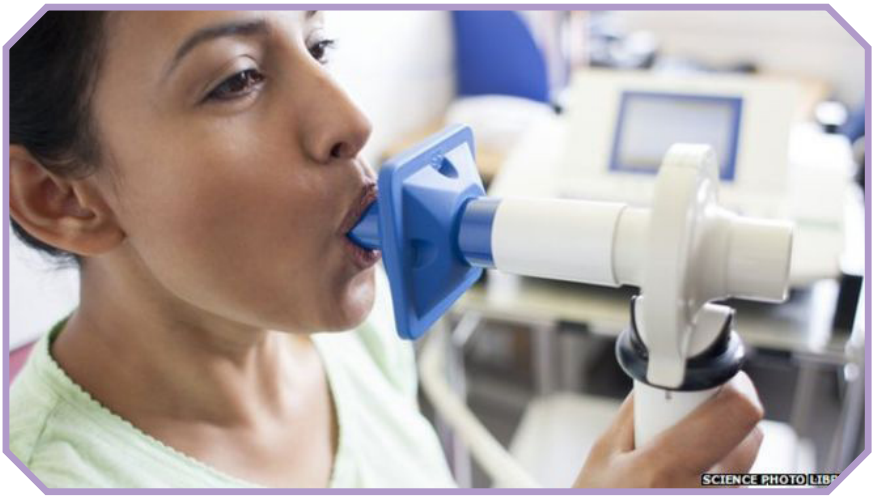
DNA has several unique features. They are universal and present in all living cells. Unlike other organic compounds DNA is a stable molecule. The most important feature is that it is possible to remove DNA from cells and reintroduce it into other cells without any damage. Therefore it is possible to separate it into fragments, and introduce fragments with new genes and change the genes. What is done in biotechnology by using genetic engineering techniques associated with our genome, is to use there transformations as a technological tool for the benefit of humans.

Many of the outcomes or products of biotechnology have been carried out for improvements in the agricultural field. The damage caused by insects to crop plants is a major threat to farmers. One of the main benefits of biotechnology is the production of insect resistant plants in order to prevent such damage. Bacillus Thuringiense contains the genes which produce substances toxic to insects. The ability to produce these substances toxic to insects has been conferred to crop plants by separating these genes of from bacteria and introducing these genes to the crop plants. What happens in this instance is that the insects which visit the plants to seek the juices die due to the toxic substances in the juices. Therefore it is possible to dispense with the use of insecticides on crops. The examples for these are maize, brinjal, cotton, soya and canola. The production of papaya plants resistant to the ring spot virus and tobacco plants resistant to the Tobacco mosaic virus are also fine examples for this method of crop plant protection using biotechnology.



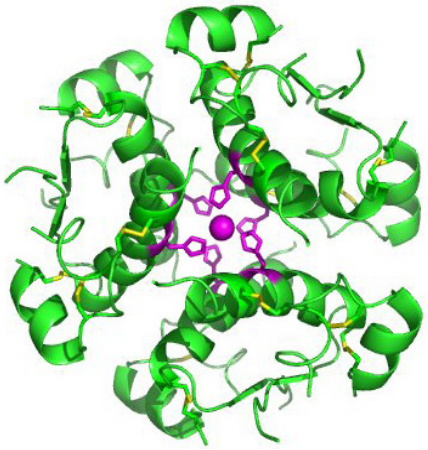
Also in the Asian countries where rice is the staple food a large percentage of the children suffer from vitamin deficiency. In order to alleviate this vitamin A deficiency the golden rice has been produced and released to the market. In these instances the genes which produce vitamin A in species of the Erwinia bacterium have been introduced to rice plants. Similarly as a solution to the problem of quick ripening resulting in the damage of tomato when transporting them, tomatoes in which ripening is delayed and able to withstand crushing have

been produced. Other examples are crop plant varieties which can withstand drought conditions, extremes of salinity and extreme cold periods. Cattle which produce a higher yield of milk and meat which are more nutritious and fresh and sheep with more wool are examples of animals produced by gene technology. Similarly recombinant cows and she goats which are capable of producing milk similar to mothers (human) milk have been produced.



Gene Technology in Medicine

Another advancement in this technology is in the development of medicine. Many engymes and vaccines, hormones used



in medicine are being produced on a large scale using genetically modified or recombinant bacteria. The hormone insulin given to nearly 1/3 of the global population affected with diabetes is the main example. Earlier insulin was extracted from pigs. This supply was not sufficient to meet the demand. Also the porcine insulin had harmful side effects. But today the human insulin (Humiarlin) is produced on a massive scale, in this manner.

Types of Drugs

Biotechnology is used as a tool in the identification of diseases, to prevent diseases for which there are no methods of cure, for the treatment of genetic diseases, in the production of vaccines, blood anticoagulants etc. A fine example for this is the hepatitis B Vaccine. It is possible to produce large quantities of this vaccine by introducing the hepatitis B Virus into yeast cells. Also it is possible to allay the "Vaccine phobia" in small children by introducing the therapeutic factor in the vaccines into fruits such as bananas so that the vaccine could be consumed as a food.

What is done during gene therapy is that the genes which cause diseases, or genes that are mutated or changed in some aspects are identified and then instead of them, "corrected" genes are incorporated so that the genetic diseases are treated in this manner. Gene therapy is used to treat certain cancers, sickle cell anaemia and cystic fibrosis which are genetic diseases. In these instances healthy genes are introduced in place of the faulty genes. So far about 4000 genetic diseases and the loci of the causative genes in the chromosome have been identified. For example the gene for Huntington diseases is in chromosome 4, gene for sickle cell anaemia is in chromosome 11, that for Retinoblastoma is in chromosome 13, and the gene for Alzeiners diseases is in chromosome 21. The first attempt to correct a disease using this technology was in the year 1990. In this instance the girl named Ashanthi de Silva was treated for the genetic diseases SCID (severe combined immune deficiency

disease). Here the white blood cells were removed and instead white blood cells into which the "corrected" genes were included were introduced into her blood. For a few months her immunity system was restored to normal. The youth Jessie Gelsinger died in 1999 while being treated, recording an unfortunate incident in the gene therapy method.

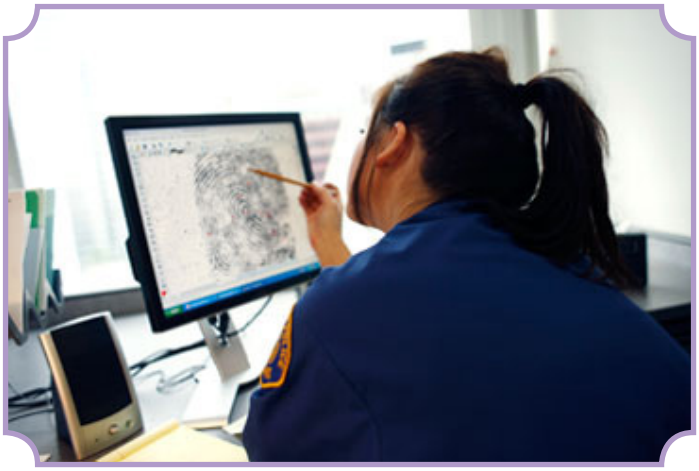
Industrial Sector

Using the unique features of the genome and the discoveries in genetics, many things have been done for the development of the industrial field. Large scale production of enzymes, proteins and food additives are some examples. In these instances mostly microorganisms including bacteria have been used. The reason is because it is easy to introduce the recombinant DNA molecule into microorganisms. Enzyme invertase, the enzyme chymosin used in the cheese making industry, amylase enzyme used in the baking industry, the practices used in the manufacture of beer and wine are products of gene technology. In addition there are many plant and animal species which have been subjected to genetic modifications using this technology. A tobacco plant into which the gene responsible for the production of luciferins has been produced. Luciferin is responsible for the fluorescence in the firefly. So the genetically modified tobacco plant also fluoresces. Another example is the production of rose flowers which are blue in colour when the gene producing the blue colour pigment is introduced into rose plants. The baby monkey named Andy is an example of a genetically modified animal. A gene producing the protein responsible for the green florescence in jelly fish was introduced into this monkey. The aim of producing such an animal was to carryout research for finding treatments for diseases such as Alzheimer and AIDS in man.

Today the sequence of bases in the DNA of the genome is extensively used to identify diseases. It is seen that under most disease conditions simple Nucleotide Polymorphisms occur.

Also here the regions of the human genome which are different in each individual, not copied and with repetitive sequence are employed. The laboratory technique known as the polymerase chain reaction (PCR) is employed to increase the copies of the DNA fragments that are used in these identifications, providing a method of personalized medicine specific to individuals, has now received attention. Differences exist in the way a drug meant for the same disease acts in different people. Therefore various allergies appear in some people. It is such allergies which caused the death of some children who were vaccinated with a generally given vaccine. The vaccine which was toxic to the children died. This happened because of the difference in the genome in such persons. The human genome project which is a global undertaking has been completed. By now all the genes and the regions of DNA that are not genes have been identified. Through this it is possible to obtain all data regarding the genome of each individual. What is expected to be done for personalized medical treatment is to produce the DNA data of the genome for each individual? This would serve as a "document" which is specific to each person. Through this it would be possible to provide medical treatment which is much safer. DNA finger printing is another unique technology based on the characteristics of the genome. It is a technique based on the genetic differences in the loci of

the genes and used to confirm the identity of individuals. The genetic information stored is according to the sequence of bases in the polypeptide chains. The regions that provide the genetic information in the DNA polypeptide are the code containing copied regions. The sequence of the bases in these regions is almost identical for a given species. The region of the DNA polypeptide chains which do not store the information necessary for protein syntheses are called the "not copied" regions. The quantity and the sequence of bases in the regions not containing the genes are very much different in individuals even if they belong to the same species. Most of the genomes in humans consists of such regions which are "not copied" and these regions are specific for each individual. Therefore these are used for the very reliable identification of individuals by the DNA finger printing technique. There are many uses of this technique. This technology can be used to identify individuals with greater accuracy. It can be employed to identify criminals, to confirm the paternity and maternity of individuals, to identify the blood relations and to identify people who have died either by accidents or disasters such as tsunami's and to confirm the identify of people who have been subjected to "disappearances". The landmark instances in Sri Lanka when the DNA finger printing technique was first introduced are in the identification of the suspects in the mass murder in the year 1999 at Hokandara, suspects of the murder of the foreign women Rita John at Crow Island the same year, and the identification of the parents of the female suicide bomber during a Presidentaical election campaign. It was possible by this technology to identify the real mother of "Tsunami baby 81" of the tsunami disaster when many mothers claimed the maternity of the baby. Similarly another much publicized recent instance of using this technique is for the identification of murderer of the child "Seya".



However there are many ethical aspects to be considered when introducing the new discoveries of gene technology to the market. The reason is that the new inventions produced using genetics and biotechnology are new species of living organisms which do not exist

Table 1. The practical application of DNA recombinant technology

Product	Practicle Application	Effects in the body when deficient
Insulin	Regulation of blood sugar level	Diabetics
Interferon	Control of viral infection	Cancer
Interleukin	Regulation of the immune system	Cancer
Human lung surfactant	Regulation of blood sugar level	Respiratory problems
Relaxin	Dilation of the birth canal during child delivery	Problems during birth of babies
Somatosatin	Limiting body growth	Unusually tall
Tumer necrosis factor	Cure of cancers	Cancer
Artificial natriuretic	Reduction of high blood pressure	High blood pressure
Tissue plasminogen		Cardiac problem
Activator		
Chymosin	Simulation white blood production	
Erythropoetin	Simulation white blood production	Anaemia
Clotting factor viii	Simulation of blood ploting	Haemofithilia
E 5 antobody	Control of toxic substances in the blood	

under natural conditions. There are agreements with many codes of ethical consideration to abide by when making such organisms and their products. The reason is because when these organisms are released to the environment, they may have effects on the natural balance and stability and also there may be ill effects if humans consume them. Many problems can exist in the society regarding genetically modified organisms. Allergies, production of new toxic substances, transfer of antibiotic resistances to gut bacteria are some of the possible ill effects on humans. Unexpected gene flow between plants, production of weeds resistant to weedicides, death of useful insects by the entry of toxic substances produced by the insect resistant plant. The genes incorporated into insect resistant plants produce toxic substances which enter the body of the beneficial insects harming them. Also the unique value of natural organisms may be affected. The mixing of genes between living species may disturb the balance of nature. Also there may be unknown effects in biodiversity. It is likely that plant, animal and microorganisms may be destroyed. There is great opposition by vegetarians regarding the consumption of plants into which animal genes have been introduced. Also such advanced technology can be used only by companies in the developed world.

Therefore other countries fear that the developed countries may dominate food productions. This may also open the avenues for piracy of biological resources due to the use of natural resources by foreign countries. Due to these reasons there is substantial opposition to biotechnology and transgenic organisms. Amisdst these concerns it is essential to use biotechnology only for the advancement of the human society.

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