Editorial

Science and Commonsense in Healthy Living

The UNESCO initiated World Science Day for the current year focuses attention on the theme 'Science and Healthy Living'. The Science Magazine, Vidurava, has lined up six articles written by knowledgeable persons that deal with various scientific aspects of healthy living.

In dealing with this subject, it may also be relevant to explore the global scene in respect of the hotly debated issue of healthy living in the wake of the rapidly changing lifestyles. It is no secret that the greatest concern today is the highly unsatisfactory condition referred to as obesity resulting from excessive consumption of processed foods, which is one of the most significant contributory factors for what are widely recognized as non-communicable diseases. It has been claimed that in the US alone, one-third of the adults and over 12.5 million children and teens are obese, and in the last 30 years obesity in children and teens had tripled.

Lisa Sasson, a New York University Professor of Nutrition claims that there is a psychology component in eating, especially when one is conscious of weight loss, though sticking to the correct "Portion Size (of food) is half the battle". It has been found that the so-called portion size in American restaurants had doubled or tripled in the last 20 years, and it is changing the concept of a normal meal. The situation in Sri Lankan restaurants cannot be any different. In fact in a recent review article published in a Sri Lankan newspaper (Daily Mirror of 16th October, 2016), Dr. Navoda Atapattu and Dr. Prasad Katulanda, two recognized endocrinologists, state that people very confidently claim that they consume regularly kurakkan roti, rathu bath (red rice), mung, kola kenda and plenty of fruits, which no doubt are wholesome and nutritious. But the reality is that the portion size is huge, and what is also ignored is that kola kenda is laced often with thick coconut milk, which has its own fatty content. Dr. Katulanda also makes the point that some people after consuming a large glass of kola kenda indulges in another meal, making it a double breakfast, while Dr. Atapattu explains that the response in such instances should be a "portion exchange". As an example of what is meant by portion exchange is that if one intends to have a large banana as a desert, then the main meal must comprise only of half a cup of rice instead of a full cup of rice.

In a study of 173 obese women of 25-30 years of age, researchers had found that swapping out sweetened beverages with plain water was linked to weight loss independent of diet and exercises. It is in fact said that one can of soda water (in the US) contains 10 teaspoons of sugar, and in the US people are said to drink around 500 cans of soda every year, equivalent to 52 pounds (approx. 23.5 kg) of sugar.

Dr. Navoda Atapattu insists that it is commonsense that "greens, greens and more greens" should be the answer for healthy living, while Dr. Katulanda underscores the 'non-value of sugar, which he stresses has only 'empty calories' with no nutrition, no protein, no fibre, no minerals and no vitamins.

Thus we see that apart from the great contributions made by science and technology, especially in evolving some of the most innovative and sophisticated techniques to help us enjoy a healthy life, commonsense should also prevail all the time to support the developments resulting from science.

M. Asoka T. De Silva

Ancient Medicine and Health care practices in Sri Lanka

Prof. Gamini Adhikari



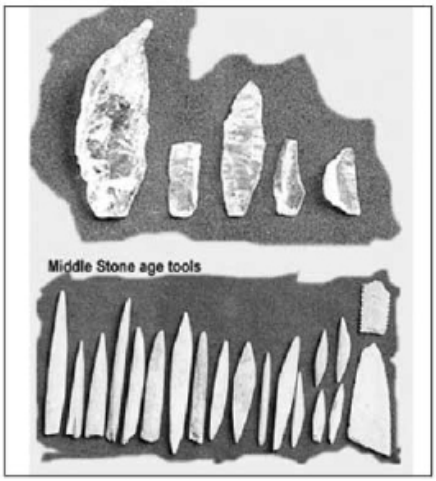
Introduction

The ancient medicine and healthcare in Sri Lanka can be considered as having a history of at least 10,000 years. This is the period of stone age when human settlements of this country existed. Information obtained through excavations by archaeologist have confirmed that these have evolved over a number of eras. Historical information has recorded certain conditions and facts related to ancient medicine. It is important to discuss the ancient medicine and healthcare practices under three time periods as follows. (i) Protohistoric period covering 10,000 to 1000 years back (ii) The prehistoric covering the period 1000 to 300 BC and (iii) the historic period covering the period 300 BC to the present day

The medical and nursing practices during the proto historic period (48,000 BC to 1,800 BC)

There is evidence to show that there lived groups of stone age humans in Sri Lanka as early as about 500,000 years ago.

During this long history, the post Mesolithic era is considered as the last stage in using stone tools. The *Homo sapiens* that lived in this era would have faced threats of various diseases. Evidence has been found which leads us to believe that during such situations they would have made use of different medical treatments, nursing practices, drugs and medical implements. Accordingly the main items that have been identified are grinding stones, stone implements, bone implements and mineral substances. Evidence that humans of the prehistoric era have painted pieces of human bones with red ochre has been found from the preincts of the Fahian cave. These are probably



about 48,000 years old. Similar evidence has been discovered from the Alawala Pothgul cave, and C14 dating has confirmed that it belongs to a period of about 14,000 years ago. Examination of the skeletal remains of humans who lived in the stone age has confirmed that they have died at different ages in their lives. In examining the probable causes that led to their deaths at a young age, it is justifiable to conjecture that they would have been victims of various diseases, and equally they would have discovered methods to overcome them. We can surmise that the science of medicine would have developed accordingly. Even though no complete studies have been carried out relating to Paleopathology of these parts of human bones found from protohistoric excavations, examination of these bone collections confirm some basic evidence regarding certain diseases that existed. Particularly it is anticipated that several research studies conducted by the osteoarchaeology section of the Postgraduate Institute of Archaeology will in the future bring to light information regarding oral and dental diseases. During the mesolithic era that is, from about 48,000 years ago, various treatments

have been employed in Sri Lanka to maintain the health of humans. Similarly there is evidence to indicate that action has been taken to safeguard good health through the food consumed. Ancient humans had a proper understanding of the types of plants and animals relating to their gradual domestication. This can be recognized through the study of the caves they lived in and the open burial sites



Certain findings of the archaeological excavations can be considered as materials used for medical, health and hygienic purposes. Discovery of materials such as grinding stones, red ochre, mica etc, made during excavations of Batadombalena in Kuruwita, Fahien lena at Bulathsinhala, Belilena in Kithulgala, Alulena in Attanagalla, Alawala Pollgullena which are located in the wet zone of Sri Lanka can be considered to have been used to treat cuts, borings, contusions and bone fractures. Comparision with anthropological studies helped to understand that red ochre was applied on the human body to stop acute haemorrhage and to get protection from insects such as flies and mosquitoes. Different types of graphite have been used in such ointments. Intellectuals are of the opinion that grinding stones have been used to grind plant materials used for medicines. Samples of phytoliths obtained from these grinding stones are still being analysed in the archaeological Botany unit of the London University. Definite conclusions can be reached when the results of these analysis are confirmed.



It is probable that the early humans applied various types of clay to remove any dirt, specially on the skin. Information is available in Buddhist literature which shows that the Buddhist monks applied clay and washed it off after ablution.

Among the stone tools and stone strips found during the excavations carried out in the prenicts of Sigiriya Pothana cave there were nine tools with unique features. It can be believed that these implements were used for some purpose beyond the ordinary use of stone tools. They resemble the modern surgical instruments. In the matter of shape and features for cutting purposes also it can be believed that they were used for a specialized functions. No research work has been conducted in Sri Lanka regarding these implements. However research on a global level has found evidence to show

that Homo sapiens during the Mesolithic and the new stone age eras had carried out various surgical operations using stone implements up to the end of the 6th decade of the 20th century. Well experienced midwives in very remote villages used a piece of glass shaped from the bottom piece of a glass bottle to severe the umbilical cord during child birth (or delivery) that took place in homes. It can be believed that humans gained ecperience for orthopaedic treatment and treatment of bone fracture by treating domestic animals.

The fact that man has been engaged in research activities using animals is shown by the drawings discovered from Bimbethka cave in India. Although there is no definite evidence of medical methods used during the protohistoric era in Sri Lanka, it is possible to gain some ideas through the information stated above. Archaeologcal research evidence has confirmed that groups of people possessing very advanced cultural characteristics and a very advanced cultural social system existed during the prehistoric period which followed.

Prehistoric era (1000-300 BC)

The period around 3000 years ago represents the prehistoric era in Sri Lanka. Only a few human settlements of this era had been found. Therefore information regarding medical methods is also very scarce. Evidence has been found that people of this era had used metals and clay and to some extent stone implements for their activities. It is not possible to consider that communities of these people which were undergoing a technological revolution were not subjected to diseases. However, during this period, because the bodies of their dead were cremated in cemeteries, evidence at least from bones which could have been used for research has been destroyed. However, the urn burial system has been discovered from the Pomparippu cemetery. From this place human remains of individuals of various age groups have been found. Among them are remains of low age groups. Such deaths of low age group persons could have been due to diseases or illnesses. The dental diseases that the humans had during this period have been easily identified, but the other diseases have not been identified. However, the types of clay vessels discovered indicate an outstanding advanced technology of their material culture. A study of the shape and use of these vessels show that some of these may have been used for the preparation





of medicinals. Clay vessels used for the preparation of various medicines and for the storage of various ointments and oils have been found through archaeological excavations. They resemble the clay vessels used in the preparation of Arishta, forments and poultices as used in the present day system of Sinhala medicine. In the excavations conducted at the Yatigalpotha cemetery in the Galewala region, very small clay vessels believed to have been used for the storage of ointments and oils have been found.

Tools of various shapes made from copper rods have been discovered during the archeaological excavation of burial sites belonging to the prehistoric age. It is possible to believe that very likely they may have been used for medical purposes during the prehistoric age. Some implements that have been discovered during the excavations of Polonnaruwa Alahana Pirivena belonging to the historic age bear a very strong resemblance to the implements of the prehistoric age. Therefore it is possible to believe that these implements were used in the treatment of people as well as domesticated animals. Evidence has been found to indicate that ancient



medical practitioners of Sri Lanka had used copper rods for therapies involing cauterization. These instruments should be investigated by medical practitioners or researchers with a knowledge of ancient medicine. By deep research into the material culture a substantial amount of information has been recorded on medicines and hygrene during the historic era. Uragoda has analysed multiple aspects of the medical history of Sri Lanka in his long discussions. Similarly Jinadasa Liyanaratne has presented a long description of the subject in has book titled Buddhism and Traditional Medicine in Sri Lanka. A very long paper on the ancient hospital system in Sri Lanka has been presented in Bangalore in 1995 by Professor Leelananda Prematileke and Professor Arjuna Aluvihare. In this paper they have presented a logical analysis of the surgical instruments discovered during the excavations carried out in the Polonnaruwa Aluhena Pirivena. In addition information is also available in inscriptions. The leading examples of these are the Medirigiriya inscription and the Mihinthale rock inscription refering to a hospital in Mihinthale and the Jetawana rock inscription. The inscription of Emperor Asoka of India mentions that hospitals and therapies were provided to human beings and animals.

In the rock inscription of the Indian Emperor Asoka it is referred to as "Human and Animal Therapy". In addition the information on hospitals and hygiene mentioned in Mahavansa can be considered important because it is the most ancient record made in the historic period. Some of the information in Mahavansa has been currently confirmed by archaeological excavations. In the meantime Alahana Pirivena hospital complex, Mihinthale, Medirigiriya and Mahavihara have been identified through excavations conducted by archaeologists. Research carried out regarding these Vansa literature bears evidence to the fact that kings had involved themselves in hospital activities and some of them also functioned as physicians. One popular story relating to king Buddhadasa's treatment of a cobra proves the fact that they had a knowledge of veterinary medicine. The age old saying "Kingship or Medicine" praise that the practices of medicine was equated to the status of kings. Therefore it can be shown that from the time of Pandukahaya up to now medicine and the practice of medicine have received sponsorship from various quarters and levels.

It is necessary to present at least a brief account of the role of Buddhism related to the diagnosis and cure of illness along with the advent of Buddhism in Sri Lanka in 3rd century BC. Buddhist teachings contained a great deal



King Buddhadasa



of information about medical treatment. Therefore the Buddhists have assimilated these into their lives. Certain *suthras* in Buddhism refer to many diseases. In these are mentioned the diseases that people are subjected to and also their causes. It has also being said that by chanting and listening to *Pirith* diseases have been cured. The causes of diseases are explained as follows *"pithata samuttana, abhada, semmaha samuttana abhada, watha samuttana abhada, utuparinamaja abhada, opakamika abhada, kammavipakaja abhada.."* According to indigenous medicine diseases are determined to be caused by *"sem, pith, waatha ha gadathu"*. It can be shown that they have used the infomation in *suthra* sermons.



Also a number of diseases are mentioned. One example is the dialogue related to the illnesses suffered by Girimananda. Thero. This sermon of the Buddha mentions a list of ailments and diseases in a list of 34 diseases such as *"chakku rogo, sotha rogo…. Ansa, pilika, bagandala"* it is possible to give an analysis of these diseases which goes beyond the simple presentation of ideas in the form of *Pirith*. It is possible to show that the *"Besajja bandanaya"* sermon in the *Vinaya Pitakaya* (code of discipline for the monks) is a summarized composition of the diseases suffered by the Buddhist priests, their causes, treatments and therapies that should be provided. It shows how the various causes of diseases, and how the afflicted persons were cured by chanting *Pirith*.

In such instances Buddha has been referred to as the *"Besajja guru"* in Buddhist literature. It means that Buddha was considered as the teacher of Physicians/Doctors. In a sermon delivered on the occation of a serpent bite, serpents have been classified into four royal casts or as *tinegen. "Bandha Piritha"* This *Piritha* was chanted on the occasion of the passing away of a Bhikkhu due to a serpent bite: *"Virupakakan abhirajakuulan, erapathan abhirajakulan, jabyuputhan abhirajakulan, kanagagothamakan abhirajakulan.."* Through this we can appreciate or recognize the knowledge that prevailed at that time relating to the identification of the serpent and the diagnosis of the nature of the serpent bite and treatment. It can be shown through Buddhist literature that they have gone further than the therapies in medicine at that time. They have put forward basic ideas of present day forensic medicine. In the *"Nawasiwathikaya"* of the *"sathipattana suthra"* the ten stages of transformation or decomposition that a dead body or corpse under goes as time passes have been described. Through the study of these stages such as *"vipubaka, vineelaka, vikakithaka,*





hatha vikaithaka, vikkayika" the changes that a dead body goes through from the time of death upto the time till only the skeletal remains are left, the subject streams such as modern forensic medicine would have developed in the field of medicine. Under these circumstances activities related to medicine and hygiene developed to a high standared in monastic complexes. In this manner, and taking into consideration the information from Buddhist literature also, medicine and hospitals in Sri Lanka would have come into existence. Archeaologists have discovered several such monastic hospitals in Sri Lanka. Three hospitals existed in the prenicts of Mahaviharaya near Abhayawewa and near Thuparamaya. Views have been put forward regarding ground plans and the architectural features of these hospitals. Among the other recorded hospitals, the ones at Mihinthale, Medirigiriya and the Polonnaruwa Alahana Pirivena are the main ones. Of these hospitals various types of treatments have been provided to the monks. Surgical instruments have been found from these sites, which confirm that the surgical operations would have been performed on these monks. It is possible that hospitals existed for laymen. However no excavations have been done upto now in such locations. Therefore upto now archaeologists are unable to give any information regarding any hospitals that may have been built for laymen. Because such sites have not been discovered upto now, no excavations are possible.

Hospitals meant for monks revealing their ground plans and medical instruments have been discovered during excavations. The most explored place is the Polonnaruwa Alahana Pirivena, and by the information obtained through these archaeological excavations it can be conjectured that these hospitals had operation theatres and had facilities to treat resident patients for other medical conditions. One can gain an idea about this by examining and comparing the ground plans given below.

Implements found during excavations

The main and outstanding surgical instruments have been recorded from the Polonnaruwa Alahara Pirivena project. By comparing these surgical implements with the modern ones and explaining how they were used Professor Arjuna Aluvihare has provided a substantial amount of valuable information. These implements indicate a comparative peak stage reached through experience. Photographs of these instruments are given above. One can grasp the comparison between the ancient and the recent implements. Each and every medicinal canoe discovered from every hospital has been turned out from a single solid block of granite. This medicinal



canoe which can accommodate a fully grown adult must have been an essential feature of a hospital. The reason being that they have been found from all ancient hospital sites. It is important to note that even though other evidence has been destroyed due to environmental or other causes the medicinal canoe turned out of a stone boulder has survived.

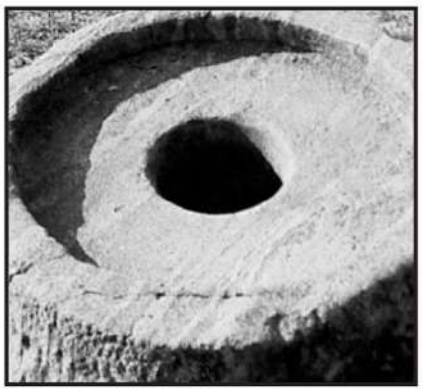
A large number of grinding stones have been recorded from the Polonnaruwa Alahara Pirivena hospital. They are of various sizes and shapes. These grinding stones are housed at the Archaeological museum of Polonnaruwa. Also a large number of Chinese clay pots and their fragments have been found. Special attention must be paid to these clay vessels. Variously shaped pots and kitchen utensils have also been found from among them. If these Chinese vessels were used for medical purposes/ industry, the contemporary Sri Lankans may have also followed Chinese pratcices in medicine. It is necessary to carry out broad research on this subject.

However, it is necessary to study the material culture of some hospital complexes as a whole. Also the identification should be done by carrying out excavations on a finer scale, and by doing wet and dry sieving separations and employing fine microscopic examinations. Furthermore, studies should be carried out with respect to fossil pollen. The reasons being that in this historic age various flowers have been used to anaesthetize patients. In confirming this it is also possible to obtain ideas about the types of plants used for other medicines. Pollen analysis and analysis of silican bodies become very important in this regard. It is necessary to confirm the above findings through accurate and fine analytical methods.

Hygeine and Health protection methods

It is possible to obtain various types





of information from Buddhist doctrine and literature relating to monks, nuns and male and female devotees, and the four fold followers. Discussions have been carried out on various sanitary methods begining with the very insignificant occasions such as relieveing one self (defaecation and urination) going up to the higher sanitary practices. Also the steps to be followed when constructing lavatories and urinals have been stated. Instances where these have been confirmed through archaeological excavation are available. The best example for this is the urinal pot seen in the Abhayagiriya monastic complex where the urinal pot has been constructed taking into consideration the cleansing or "treatment" of the urine, getting rid of the unpleasent smells and the hygienic aspects, before dischanging it into the ground soil. The toilets in the Anuradhapura Batahirarama Patharagara complex are very fine examples, when considering the sanitory aspects. In this article a very short description has been given on ancient medical system and hygiene. It is expected to present the results of other research as a supplementary note to this.

When considered as a whole, the historical facts presented here is evidence that from ancient times Sri Lankans were aware of very good medical and sanitation methods, while safe guarding their identify. However it has to be pointed out that this research should be carried out on a better scientific basis. It is expected that in the future these research activities will be conducted on a broder basis and their results will be presented to the reader.

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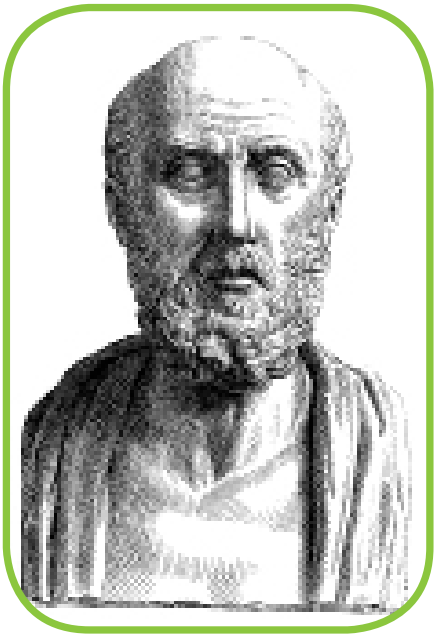
Science for Healthy Living

Prof. Raveen Hanwella



Off the coast of Greece there is a little island called Cos. It would have remained unknown if not for a famous person who once lived there. His name was Hippocrates and he was born around 460 BC. Hippocrates is considered the Father of Scientific Medicine. Why was Hippocrates so honoured? Hippocrates lived in an era where scientific dissections were not allowed and there were no really effective medicines. However, he was a keen observer and described the symptoms of common illnesses accurately. His greatest contribution to medicine was to attribute the cause of disease to natural rather than supernatural causes. He is quoted as saying "Men think epilepsy divine, merely because they do not understand it. But if they called everything divine which they do not understand, why, there would be no end to divine things."

Before Hippocrates, Greeks attributed disease to supernatural causes and many temples were set up in honour of the Greek gods of healing, Apollo and his son Aesculapius. Persons suffering from various afflictions came to these temples. They would live in the temples until they saw a dream in which the gods revealed the means of cure for the patients' disease. Some did get cured, more through natural healing than through divine intervention. Hippocrates did not



Hippocrates

at the time have the necessary knowledge to understand the exact cause of the diseases that he observed. But he did understand that there was a natural cause which someday in the future would be found. Again to quote Hippocrates, "We will one day understand what causes it (referring to epilepsy), and then cease to call it divine. And so it is with everything in the universe." How true and how prophetic.

In this article I will illustrate through the lives of selected scientists how science has increased our wellbeing. What do we mean by the term science? The word science probably brings to your mind images of people in white clothes working in laboratories boiling strange substances in beakers, of astronomers peering through telescopes at distant stars, or the launch of a spacecraft. These images represent only one aspect of science. Science has many facets. It is both a body of knowledge as well as a process. To you, science may seem like a collection of facts which you find in your textbook. Science is more than that. More importantly it is a process of thinking and discovery that helps us to link isolated facts into a comprehensive and coherent understanding of the world. This

way of thinking is called the scientific method.

The steps of the scientific method go like this, First you make observations on some interesting phenomenon you have seen. Next you ask questions about it and gather more information. Then you form a hypothesis which is a tentative description of what has been observed and make predictions based on that hypothesis. Then you devise an experiment to test your hypothesis. You analyse the data, draw conclusions and accept or reject your hypothesis. A wise scientist does not stop there. You will then do the experiment again to see whether the results are repeated, as sometimes mere chance or an error can give results which are not true. Then when you publish your results your peers will look for flaws in your arguments. They will repeat your experiments and see for themselves whether your results are true. Finally if your findings survive these tests you will be honoured for your contribution to science. Who knows if your findings are important enough you might even be awarded the Noble Prize, the most prestigious award in science.



Statue of Ignatius Semmelweis



A word of caution here. Not all questions can be answered with the scientific method. To illustrate my point let me quote from what a perceptive reader once wrote to an editor of a scientific journal. He wrote, "There are questions of faith, such as 'Does God exists?' There are questions of opinion, such as 'Who is the greatest baseball player of all time?' There are debatable questions, such as 'Should abortion be legal?', And then there are questions that can be answered to a degree of certainty by the application of the scientific method, which are called empirical questions' in other words, those that can be largely settled by the evidence."

To apply the scientific method a question should be testable and verifiable. There is another important condition to be fulfilled. This was pointed out not by a scientist but by a philosopher. His name was Karl Popper. His beautifully simple idea was that you can distinguish between a scientific and a non-scientific statement by asking oneself if it can be falsified. If it cannot, it is not science. Let us take the observation that all swans are white. This hypothesis could be verified by observing various populations of swans from various locations. In 16th century London it was believed to be true as all swans in England were white. However in 1697, Dutch explorers found black swans in Australia. Only one black swan was necessary to prove the theory wrong. Likewise a truly scientific question has be to be falsifiable, if not now sometime in the future when the technology becomes available. Some questions are not inherently falsifiable, therefore cannot be disproven by scientific inquiry. Such a question would be, "Are there spirits?". Science can never disprove the presence of spirits. All we can say is that up to now there is no good evidence that spirits exist. The method of scientific inquiry enable us humans to explore our world, find out the principles that govern nature and use that knowledge to improve our day to day lives. Let us look at some examples of such events.

Ignatius Semmelweis was a Hungarian obstetrician who worked

in the Vienna General Hospital in the mid-19th century. In those days if one became pregnant and delivered a child in hospital there was a high chance that the mother will die soon after delivery, of an illness called childbed fever. This was in the era before Lois Pasteur as well as people did not know of the existence of germs. Semmelweis was distressed by these deaths and was keen to find the cause. There were two maternity wards in the Vienna Hospital. He observed that in the first ward, the mortality due to child bed fever was 10 percent, but in the second it was lower at 4 percent. What were the differences between these two wards?



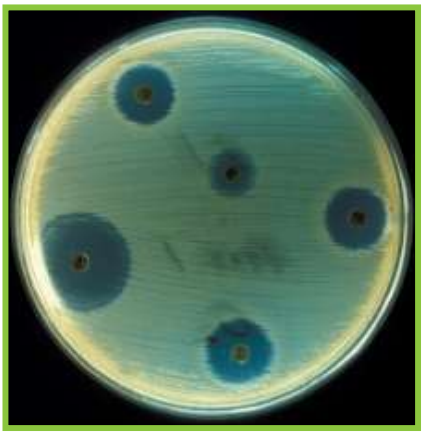
Louis Pasteur



Semmelweiss meticulously eliminated all possible differences, including even religious practices. The only major difference he found was the individuals who worked there. The first ward was the teaching unit for medical students and the second for midwives only. He observed that medical students examined pregnant females immediately after dissecting cadavers without washing their hands whereas midwives did not do dissections. He concluded that some cadaveric material was causing the fever. To test his theory he ordered all medical students to wash their hands in chlorinated lime. The results were dramatic and the mortality rate in the first ward dropped by 90% to a rate similar to that of the second ward. You would think that Semmelweiss would have been immediately showered with honours and hand washing became standard practice. But sadly, as it happens in history, men are slow to change and accept new ideas. Semmelweiss was forced out of his job and women continued to die of childbed fever throughout Europe. Semmelweiss became deeply depressed and died in a mental hospital in 1865. He was 47 years old. Only in 1904 did Hungary erect a statue to honour the "saviour of mothers."



The work of persons like Semmelweiss led scientists to think that some diseases were caused by an organism too small to be seen with the naked eye. In the beginning this germ theory was not accepted. For two thousand years, since the days of Aristotle, people thought life appeared spontaneously. They believed that fleas grew from dust, or maggots from dead flesh. This theory was known as spontaneous generation. It was another great scientist' the Frenchman Louis Pasteur who overturned this idea and proved that the germ theory was true. He showed that if he boiled a





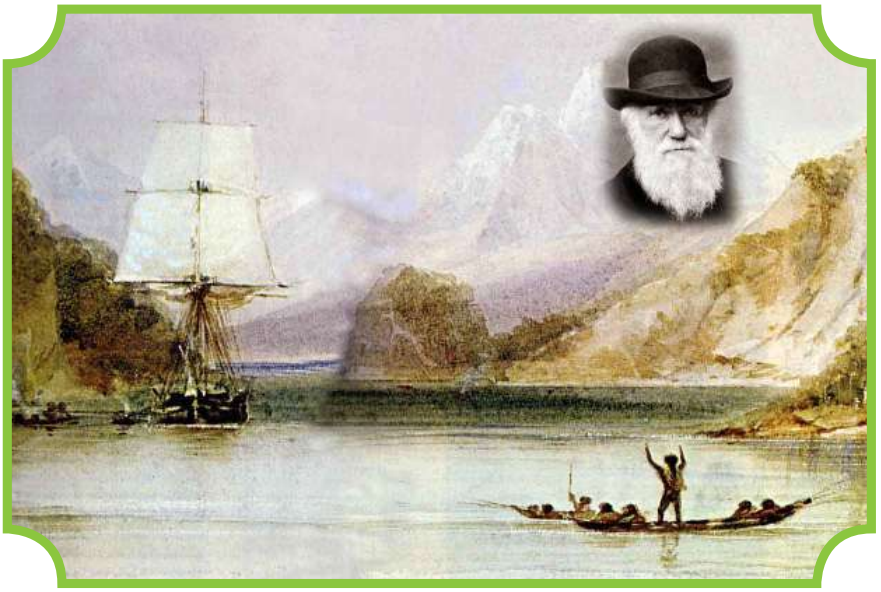
broth and immediately sealed the container it did not spoil but if he added material exposed to the air it turned cloudy. He turned this knowledge to practical use to save the wine industry of France. The wine makers found that their wine was becoming sour and turned to Pasteur for help. He speculated a germ was the cause and found that if the wine was boiled to 60 degrees Celsius the germ was killed and the wine did not turn sour. This process known as pasteurisation was later used to preserve beer and milk.

Heating killed the germs in food but there was no safe way to kill them inside the human body. It was a Scottish scientist Alexander Fleming who discovered the first antibiotic. He found that one of his Petri dishes where he was growing bacteria was contaminated with a fungus and around the fungus the bacteria has stopped growing. He correctly surmised that the fungus was secreting a substance which killed the bacteria. He named the substance penicillin. It would be many years later before penicillin could be made in sufficient quantity to be tested in humans. In the First World War more soldiers died of infection rather than from bullets, but in the last year of the Second World War enough penicillin was produced to treat all the wounded of the Allied forces. In 1945 Fleming, with two of his colleagues, was awarded the Nobel Prize for Medicine. Charles Henry de Soysa, at one time the richest man in Sri Lanka, and one of our great philanthropists, was bitten by a stray dog and died in 1890 of blood poisoning. He was 54 years old. Those days there were no antibiotics to save him.

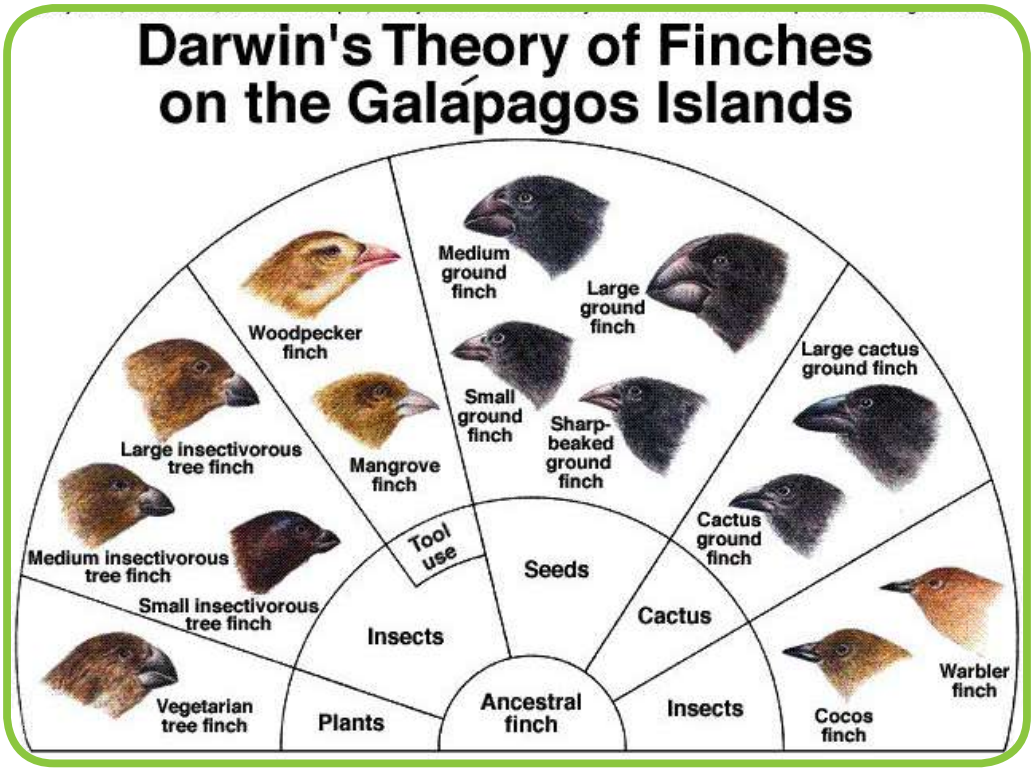
Scientific thinking does not always improve our wellbeing by new discoveries. It also helps us to think about our world in a more rational manner and free ourselves of unnecessary fear. Scientific thinking at times compels us to go beyond the confines of our traditional, cultural and religious beliefs and consider possibilities even if it makes us uncomfortable. Few scientists have shaken our view of the world than Charles Darwin. Yet more than one hundred years after the publication of his book On the Origin of Species, some schools in America still refuse to teach his theory of evolution. With the overwhelming new evidence from palaeontology evolution is no longer a theory but an established fact.

Darwin observed that every species reproduces far more of its own kind than could possibly be needed to replace the parents. But most do not survive to reproductive age. This observation laid the foundation for his theory. In 1836 Darwin went on an epic journey in the HMS Beagle. The journey lasted five years. During this journey he visited the Galapagos Island off the coast of South America. There he discovered 12 species of finches. The main differences were in the size and shape of their beaks which were adapted to the different types of food available on the islands. Based on these observations Darwin formulate his theory of evolution by natural selection. Its premises were simple but profound.

In a population organisms exhibit variations in appearance and behaviour. Some of those variations confer an advantage



HMS Beagle



for survival. If such a variation is heritable it is more likely to be passed on to the next generation. In subsequent generations there will be more organisms with the new trait. To understand this better let us take a population of beetles where the colour varies. Some beetles are green and the others are brown. Green beetles are more likely to be eaten by birds as they are more visible. The population of brown beetles will increase and with time there will be only brown beetles. Over millions of years organism can undergo profound change and new species are created. Natural selection happens purely by chance and not by design. Such a radicle idea was difficult for people to accept as it disturbs our view that we are special and unique creatures created for a purpose. It is difficult to believe that we are here merely by chance and have no special purpose in the universe.

Now let us look at some other ideas that trouble us and see how science can help to think more clearly and enable us to live more comfortably. Superstition is a belief or practice for which there is no rational basis. The Merriam Webster Dictionary defines it more precisely as "a belief or practice resulting from ignorance, fear of the unknown, trust in magic or chance, or a false conception of causation." In Sri Lanka superstitious beliefs concerning methods of warding off ill, preventing accidents and sickness, bringing about good fortune, or predicting the future are ingrained in our culture. Other superstitions such as belief in the evil eye (as waha), and the wearing of amulets are not limited to Sri Lanka but are found in other parts of the world. Superstition has heavily influenced history and though we think that it is on the wane, in this modern age of scientific thinking where objective evidence is valued, it is not easy to let go of our superstitions.

Even in a modern country like America there are twenty times more astrologers than astronomers and more people believe in ESP (extra sensory perception) than evolution. Ronald Reagan, when he was President, consulted astrologers before scheduling international summits, presidential announcements, and even the flight schedules of Air Force One. Is astrology a science (as its proponents claim)? Can its claims be validated by scientific inquiry? If astrology is a science it too should be amenable to scientific inquiry. Has there been such scientific inquiry, and if so what has been the outcome?

There have been several studies. For lack of space I will tell you about one. In 1989, Verle Muhrer an American researcher published an article titled Astrology on Death Row. John Gacy was a serial killer who tortured and killed 33 young men and boys. Here was a person with a clear psychopathic personality. A researcher visited five well known astrologers and gave each the birth time of Gacy and his birth chart (horoscope) cast by an astrologer of international repute. The researcher pretended they were his own and sought advice as to whether he should pursue a career working with young people. All

five astrologers encouraged him to go ahead. One said that working with young people would "Bring out their best qualities." Another astrologer told the researcher that "He was kind, gentle, and considerate of others." A third astrologer told him "In the past you have used your energies very well so, therefore, in this life you have a lot to contribute, and your ... life will be very, very positive."

The evidence is that astrologers cannot read a person's character from the position of the planets at the moment of birth, neither can they see into anyone's past nor predict their future. Yet people continue to believe in astrology. As the greater writer of science fiction Isaac Asimov said of superstition, "…trying to snatch folly from the minds of those who have been victimized by it is often rather like trying to snatch a bone from a dog."



To end my article I would like to go back to Darwin. Did he say that we were descended from monkeys? Actually he did not say that. It is now clear long years ago we had a common ancestor but monkeys branched out in a different direction and humans into another. Since Darwin we have now found that the heritable factor in all organisms are the genes. The genes are located in structures called chromosomes which are found in the nucleus of cells. These chromosomes are paired, one of each pair coming from each parent. In human there are 23 pairs. We now know that there are approximately 21600 genes in a human being. These genes determine what we look like. Sometimes gene change in a process called spontaneous mutation or the genes on the chromosome pair can swap. These changes give rise to the changes in the appearance of organisms that Darwin described.

Now here is a little known fact that is not described in your science text book. There is another collection of genes that is not paired and is found not in the cell nucleus but in the mitochondrion of the cell. Mitochondria are structures found in the cytoplasm of cells and help in energy production of the cell. When humans reproduce the father only contributes the cell nucleus while the rest of the cell including the mitochondria are contributed by the mother. This means that the mitochondrial genes are passed from mother to daughter only. By looking at the differences in the mitochondrial genes scientists can identify the age of a particular tribe. The greater the number of changes the older the tribe. In 2008 a study of 51 tribes from across the world showed that modern humans have emerged from a single location in sub-Saharan Africa, around one hundred to two hundred thousand years ago. They then migrated northward and eastward to populate the earth. This 'Out of Africa' theory is now accepted by most human geneticists. The urge to explore is built into our genes.

And now for the most surprising fact of all. As the mitochondrial genes are exclusively inherited from female to female we can trace an unbroken lineage of mothers stretching far far back to a few females. In the case of humans it would appear that we are all descended from one single human female who lived in Africa two hundred thousand years ago. All of us alive now and almost all our immediate ancestors are descended from a single mother. Science has given us a mesmerising and beautiful message. Despite our differences we are all one big family.

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Science for Mental Health

Dr Ranjith Jayawardana



Introduction

Health is a state of complete physical, mental and social well-being and not merely absence of disease. That is how the WHO defined health in 1946 and it has not been amended since 1948.



psychologist Carl Jung

Mental health refers to a broad array of activities directly or indirectly related to the mental well-being component of the above definition. It is related to the promotion of well-being, in which every individual realizes his or her own potential, can work productively and fruitfully and is able to make a contribution to his or her community. It also includes prevention of mental disorders and the treatment and rehabilitation of the people affected by mental disorders.

The government of United Kingdom adopted the strategy "no health without mental health" to bring mental health to mainstream in 2011.

Mental health is how we face and overcome our psychological, emotional and social problems as we go through life. As we all know, we face many problems during our lives, some pleasant and easy to solve, some unpleasant and difficult to solve. Some call these, 'stresses' which is a very popular term. It is our mental health which helps us to get over them. However, as the psychologist Carl Jung said "Man needs difficulties, they are necessary for health". We learn from the difficulties we face and emerge better equipped to face new ones. However, we also know that some of us 'stumble' mentally when we face problems.

So how does Science help us to





gain better Mental Health?

Early life

Long time ago William Wordsworth the English poet stated that "child is the father of man". This is very true. Our childhood experiences are extremely influential in shaping our strengths and weaknesses when we become adults.

Actually it is not only the mental health that is influenced by many factors in childhood, many physical diseases like obesity, heart diseases and illnesses like diabetes have their origins in childhood. Sometimes even early death in adults is due to factors that started in childhood.
It is now accepted that physical abuse in the form of beating a child, sexual abuse where children are used in sexual activities by adults, emotional abuse when children are not cared for, not receiving the love they should get and poverty in the family, all lead to mental and physical illnesses when such children become adults.
In fact things start even before we are born. That is, when we are in the wombs of our mothers. If the mother does not have adequate food, that is she has poor nutrition, or she gets physically or mentally ill, the baby will be affected.
The effects will be seen either in childhood or later in adult life.
The mother should have acceptable obstetric care during the pregnancy, during childbirth and in the period after the birth of the baby. Difficult childbirths with birth injuries to the baby could lead to brain damage and poor mental health later.
Research also shows that bad parenting is associated with poor school and later academic performance, problem behavior and aggression. Bad parenting is lack of affection or love from the parents and lack of caring by the parents. Overprotection is also bad parenting as children should be given appropriate freedom to make their own decisions.

A good parenting style would be to show love and affection, to be caring without overprotecting the child and allowing him to realize his potential.



So these are some scientifically proven factors that affect mental health early in life.

To sum up, things start before a person is born. Good nutrition for the mother, reasonably good physical health, a stable mental state free of unnecessary problems are important at that stage.
Birth of the child should take place with adequate obstetric care to prevent birth injuries.

The child should have adequate love and care from the parents





without over protection which is good parenting style. There should not be any child abuse, physical, sexual and emotional.

Mid life

It is important for people to have good social support, as humans are sociable creatures. We establish relationships, first with our family, then with other associates like friends, workmates and partners. Satisfying relationships are essential for good mental health.
We have observed that in our Sri Lankan culture, the relationship of an adolescent girl or a young woman with her mother is extremely important. If this is fractured, the young woman tends to go through many psychological problems.

There is scientific evidence which shows that exercise is really helpful for physical health, it reduces pulse rate, blood pressure and improves the capacity of the lungs.
Research also supports a positive and lasting relationship between regular exercise and mental health. Exercise is good for mental health. If you are not used to regular exercising, it is common sense to start slowly and gradually build it up. Any form of exercise is good for us. It should be an activity that you enjoy. Otherwise there is a risk of dropping out of the activity as people tend to get bored with exercise, unless they are highly motivated. It is now generally agreed that walking, jogging, running, even stationary running and swimming are good for us. It should be done at least for 30 minutes and preferably five days a week, but even three times a week is acceptable if continued regularly. Health benefits occur within about four months. There is scientific evidence that some chemicals are released in the body and the brain due to exercise, that makes us feel better. While exercising, we forget our problems and the stresses and those who may be feeling that they have lost control of their lives, gain some sense of mastery and happiness.

Use of alcohol and other drugs like heroin and cannabis almost always destroys our mental health. There is a lot of scientific evidence to show that they cause severe physical and mental disorders.
Spirituality is also important to many people. It is not just holding on to a religious belief and belonging to an established religion. Spirituality is a deep seated sense of meaning and purpose in life together with a sense of belonging and of harmony with the universe. It helps people to form a new sense of meaning which fosters hope and peace of mind. Spirituality is good for mental health.

Late life

Loneliness is now recognized as a real problem, especially in older adults. Depression occurs in the lonely, and the two are a lethal combination. Suicide is common among the lonely.





There is some recent evidence to show that even in later life, taking up leisure activities like reading, board games like checkers and chess, playing musical instruments, dancing, exercise and walking are linked with a reduced risk of developing dementia.
Regular checking of blood pressure and getting treated if indicated, would reduce the occurrence of dementia due to high blood pressure.

Loneliness could be social or emotional. Social loneliness occurs when the number of relationships and their quality are less than what he desires. Emotional loneliness is where the intimacy of the relationship is not satisfactory. So for good mental health, loneliness should be avoided.

Depression or the illness where people become very sad, which affects their appetite, sleep and enjoyment of life is common in older people. There is scientific evidence that those who are active physically and mentally, have social connections, belong to a group and are helpful to others, have less chance of developing depression. Effective treatments are available for those who develop this illness.

Another major problem in old age is the development of memory failure. As we tend to live longer, we get more and more memory problems leading to a condition called dementia. About 5% of the 65 year old population and 20% to 40% of those aged 85 years have dementia, mostly Alzheimer type, called Alzheimer's disease. Another less common type of dementia occurs due to uncontrolled high blood pressure.
Can science help to prevent or effectively treat Alzheimer's disease and other dementias?



Medications are available to stop the progression of memory failure in dementias. More research is currently under way to find a cure i.e. to reverse the process once started.

These are some of the more prominent scientific advances that would help in promotion of mental health at present.



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Science to overcome emerging Health Problems Is Meditation Useful?

Prof. Saroj Jayasinghe



Introduction

Sri Lanka is facing several emerging health problems. These range from epidemics of infections (e.g. dengue brought on by urbanization), increasing prevalence of non-communicable diseases (e.g. diabetes due to changing diet and life styles) and rising rates of injuries (e.g. high velocity road accidents in high ways).

Does meditation have a role to play in tackling some of these emerging problems? This area of inquiry is important because Sri Lanka is a country where meditation is practiced commonly. The primary objectives of such practices are to achieve certain religious goals (e.g. to become an 'Arahath' or supreme emancipation of 'Nirvana'). However, it would be useful if scientists began to explore if they have more secular benefits of improving health outcomes. This article outlines a few aspects that may interest the reader. It first begins with a section on research and then discusses some potential applications.

Research on meditation

The world has seen rapid scientific advances in the disciplines of biology and human health over the past decades. These include the ability to describe the complete human genome, analytical techniques sensitive to identify a range of compounds (e.g. proteomics) and imaging techniques such as magnetic resonance imaging that reveal internal human organs and structures in three dimensions. An area with relatively less rapid advance relates to the mind. Though Lord Buddha, often credited as the first scientist of the mind, emphasized the role of the mind as a forerunner of human activity, Western or Modern science showed relatively less interest. Meditation, a key ingredient of several religions was almost ignored by the scientific community and rarely investigated until 1960s. The initial well described studies began in the US in Harvard University on a form of meditation called Transcendental Meditation (TM) that originated in the Himalayan region and promoted by Guru Maharishi Mahesh Yogi. Subsequently, Tibetan forms of





meditation (under the leadership of His Holiness the Dalai Lama) have been investigated extensively in laboratories around the world. The forms of meditation in these countries are different from Sri Lanka. In Tibetan meditation, visualization is used to focus attention, and in TM a 'mantra' is repeated by the meditator to focus attention.

In recent times Thailand, Indian and Sri Lankan scientists have also begun to investigate the health effects of Mindfulness Meditation. Scientists define meditation as a unique mental state in a practitioner. Prof Kabat-Zinn described it as "the awareness that emerges through paying attention on purpose, in the present moment, and non-judgmentally to the unfolding of experiences moment by moment". Therefore in practicing mindfulness meditation, one becomes aware of the current internal and external experiences, observes them carefully and accepts them. This is believed to lead to a 'relaxation response' as described by Professor Herbert Benson who studied TM. More recently, mindfulness meditation has been promoted as a strategy to reduce stress by Prof J Kabat Zinn (also from the US).

Potential health benefits

There are several studies showing the effects of different forms of meditation affecting physiological functions. Initial studies showed that meditation reduces blood pressure. Experienced meditators are able to control their heart rate and respiratory rate during meditation.

Psychological benefits

Meditation is well recognized to have beneficial psychological effects. These include improved examination performance in students who practice meditation. Their ability to remember and recall facts in enhanced and they cope better with examination stress. Recent evidence also suggests positive effects of meditation on intelligence and memory. Brain regions associated with attention, introspection and sensory processing become thicker in meditators than in those who do not.

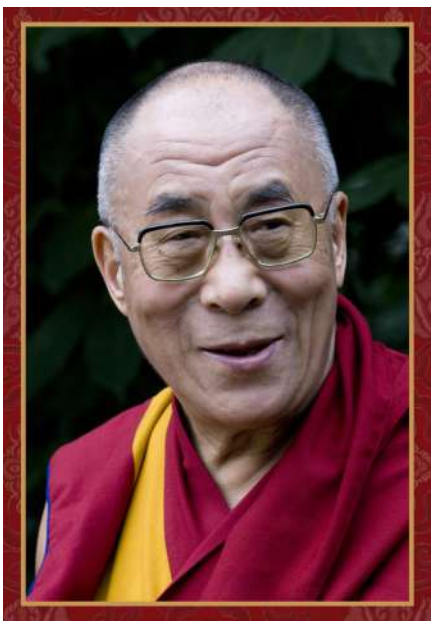
Meditators experience less stress as a result of their practice. As a result, some of the diseases associated with stress are managed better with meditation. These include persons who meditate and have better abilities to cope with distress and pain. Studies on persons with terminal cancers have shown that the patients suffer less when they meditate.

Ageing

Telomere length and high levels of telomeres are considered intracellular markers of longevity. These are terminal parts of the chromosomes which become shorter with ageing. Meditation leads to alteration of telomerase activity. Recent studies indicate a positive effect on telomere length in long-term meditators. This has led to theories that meditation has the ability to prolong life.

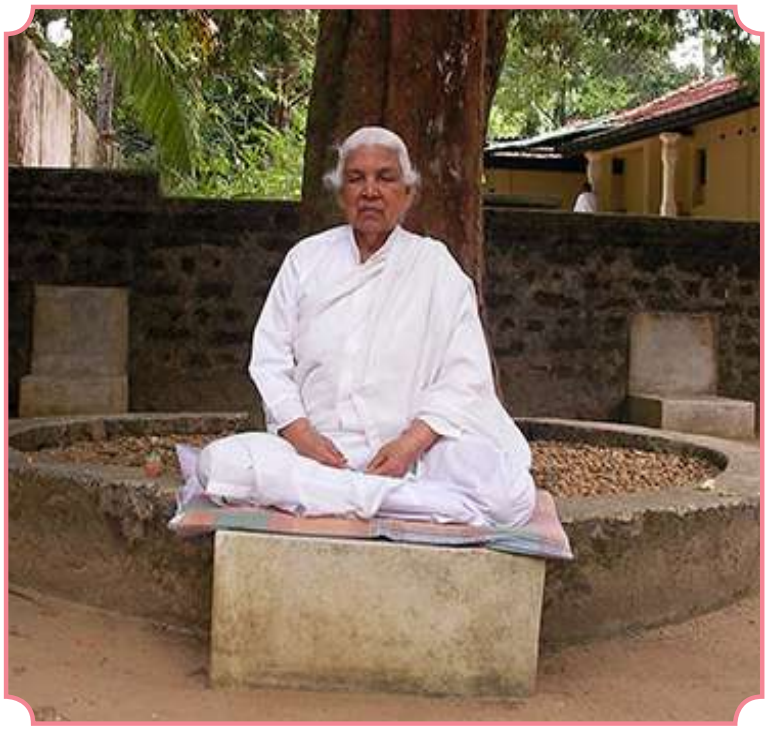
Neurological diseases

Meditation is associated with altered electroencephalogram



His Holiness the Dalai Lama

patterns (i.e. this measures electrical activity). There is widespread interest on the favourable effects of meditation on the cerebral cortex. One such condition is dementia a disease where people lose their abilities to remember and think clearly. It is common in older people and there are drugs which can slow the progress of the diseases. There is evidence that meditation is also capable of slowing the progress of dementia



Immune-mediated diseases

Studies have shown a range of effects of meditation on the immune system. Generally meditation calms the background low-grade inflammation that is present even in a healthy state. It also inhibits the response when the body is presented with a foreign antigen (e.g. by giving a vaccine under experimental conditions). The immune effects can be measured by checking on C-Reactive proteins, cell counts such as lymphocytes, and cytokine levels. There is research to show that diseases that result from inflammation (e.g. inflammatory bowel diseases) benefit from the practice of meditation.



Stress related diseases

Stress reaction is measured using cortisol level.. Meditation leads to decreased serum cortisol levels. Some of these effects are seen even with short term meditation. Therefore, scientists believe that stress reduction through meditation may help to reduce the number of persons who develop diseases such as high blood pressure and diabetes.

Conclusion

Despite the fact that meditation is commonly practiced in Sri Lanka, the scientific community and health personnel have not given adequate attention to its potential benefits. We need more research in this area. The Faculty of Medicine in the University of Colombo has commenced research in this area and hope to work closely with the scientific community, students and people of this country to harness the benefits of this ancient practice.

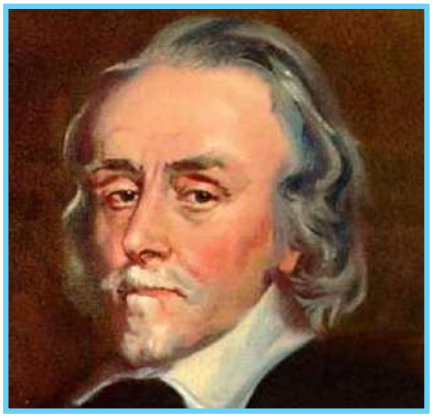
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Science, Health and Biomedical Engineering Technology

Eng. Muditha Jayathilaka



At the introductory stage of western medicine, it was similar to Greek medicine. Later it transformed into the allopathic system of medicine. This system got connected to science after Willian Harvey (ia 1628 in UK) explained the process of blood circulation in the human body.As a consequence, to a certain extent a scientific understanding was created of not only the human body, its various systems and organs, but also of the complications and of diseases. Biomedicine began in order to produce relief to patients in respect of three aspects. The three aspects are diagnose of diseases, treatment and investigations.



Willian Harvey

Another beginning which connot be overlooked was the invention of an instrument which could measure blood pressure. This instrument measures the pressure with which blood flows through the blood vessels or systolic pressure (the pressure with which blood is sent out of the heart) and the diastolic pressure (the pressure in the blood vessels when the heart is filling with blood). The first measurement is the pressure in the arteries. Today the mercury pressure meter (the sphygmomanometer invented by the French National Eliene Jules Murray in 1860) helps medical doctors to diagnose various disease conditions in a large number of organs including blood vessles, heart and the brain. Today this instrument has developed to digital pressure meters.

Cardiac diseases are the main causes of death in Sri Lanka. The E.C.G machine which provides the first clue regarding a heart attack was invented by the Dutch national Vilem Iyanthowan in 1903. The start or the beginning of this discovery was that when he immersed his hands in a basin filled with salt water he felt as if some electricity escaped from his hands.

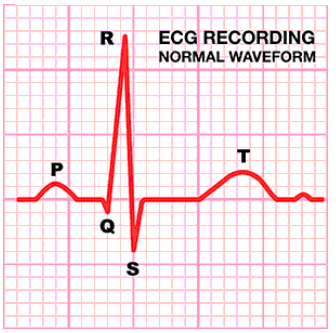


Digital blood pressure meter

This led to the situation where the electrical activity of the heart can be measured. Because parellel to this electrical activity of the heart the physical activity also takes place, it is possible to get a clue regarding a heart attack through electrocardiograph or ECG. The ECG can also help to identify various defects and abnormalities regarding the heart beat.



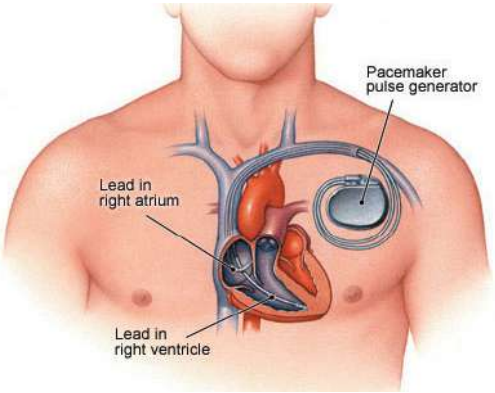




E.C.G

Another important invention associated with biological medicine is the pulseoximeter invented by a Japanese scientist. This instrument which measures the extent of oxygen saturation in blood help doctors to make observations regarding diseases. This instrument is of a great help to doctors when treating patients who have met with accidents, subjected to bleeding or having breathing difficulties. Capnograph indicates the amount of carbon dioxide in the final breath of the exhaled air. Through this measurement it is possible to assess the acid-base equilibirium in the blood and there by decide whether it is necessary to administer oxygen to a patient.
Another important instrument associated with biomedicine is the nebulizer. This instrument can supply drugs in minute quantities (less than five microns) directly into the lungs very efficiently, with ease and with minimum of side effects. Because the drug is administered directly into the alveoli of the lungs, not only are the benefits obtained more quickly, but also the side effects and complications of other organs minimized.

It is already possible to conveniently obtain the information regarding the biological activities (such as heart beat, blood pressure) of a patient in the intensive care unit using a smart phone via the wifi gateway or technology.
Another biological achievement is the dialysis machine (the blood ultra-filtiation machine) which artificially maintains the activity of the kidney until the kidney transplant of kidney patient.
Conducting heart oparations and treating without opening the thoracic cavity and the surgery done to remove stones in the gall bladder by laproscopy have revolutionized the medical treatment.
Another great achievement is solving the problems that arise due to the halting of heart activity during heart surgery by using the heart-lung machine (John H.Gibbon 1953 America).
The iron lung machine (which you would have heard of very often) which maintains the respiratory system of polio patients, can be mentioned with pride (Phillip P.Dinker).
The Continual Renal Replacement Therapy makes it possible to give relief continuously to patients and to people whose kidneys have stopped functioning due to serpent bites.
It is possible to use the pacemaker either externally, or insert it internally specially for people





whose heart rhythm is not normal or for those who have irregular heart activity. It is also possible to save the lives of people whose hearts have been affected by toxic substances such as those in Nerine (Oleander) seeds. Here a pacemaker has to be used for about two days. Manual massaging by hands has been used by doctors in order to resuscitate the heart which has stopped working in a patient who has suffered a heart attack. But to day the defibillirator (Clandus Paheter Ben - America) machine is used for this purpose. It is this defibillirator machine that is employed to revive heart activity after stopping heart activity to carryout open heart surgery. It is possible to treat a person who has got a sudden heart attack by using improved automatic defibillirator machine, until medical treatment is given.This machine can be used anywhere. Besides its use does not require a great deal of training. Cobalt-60 ray treatment has been used in the past to treat cancers. However, now the linear accelerator is used for this purpose. Another achievement in technology is the "Brachytherapy" machine which provides treatment for cancer of the cervix. We cannot forget about X-rays when talking about ray treatment. With the discovery of the x-ray radiations by the German national William Condrad Rontgen in 1895, the examination and treatment of patients has been revolutionized. It is still being improved. x-rays do not form reflections of soft tissues. However the





Fluonoscopy machine helps to locate even a tumor or cyst in the intestine.

The well known developments or improvements such as the CT scan, MRI scan, ultra sound scan, the Gamma camera, PET scan *etc.* are also achievements of Biomedical engineering.

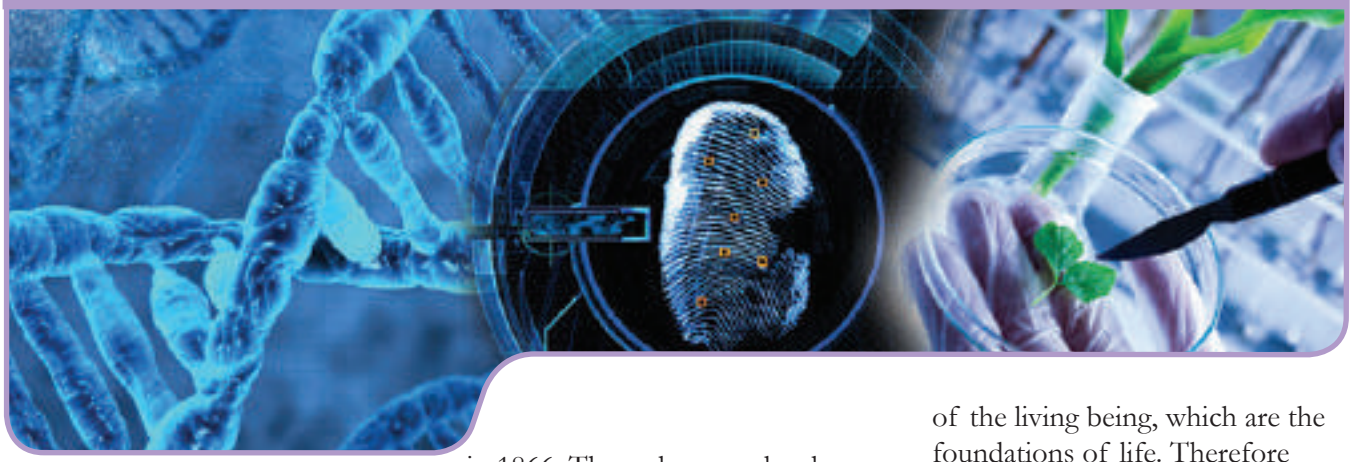
The surgical procedures for the eye and dental health have been made easy by the use of instruments in these fields. For example, today the removal of cateracts of the eye is done without general anaesthesia. Similarly immence progress has taken place in the fields of Physiotherapy, mental treatment, sports medicine by the inventions of Biomedical Engineering through engineering, electronics and digital technology.

The electron microscope is a machine that is essential today. It helps to identify most of the viruses that keep spreading today. The technology of Biomedical Engineering has reached even homes, going beyond the limits of hospitals. The digital pressure meter, blood glucometer, nebulizer and the dialysers used by some in their homes or bed rooms are evidence for this. Similarly it is possible to be informed of the rate of contraction of the heart rate of respiration, Body Mass Index (BMI), Blood cell count *etc.* through the applications that can be connected to the modern smart phones. It is imminent to be able to know the quality of calories and proteins we consmed in a meal on a given day through the use of a mobile smart phone in to which an application has been installed. Not only this it will record the calories that one burnt during exercise or while being engaged in a sport.

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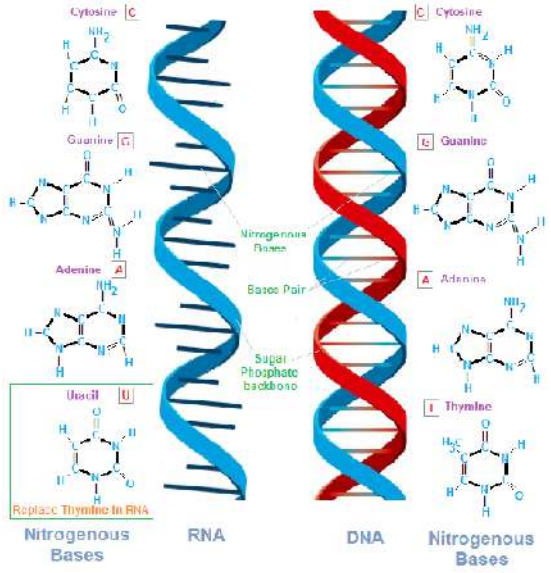
Genetics and Biotechnology for human survival

Prof. Nishshanka De Silva



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





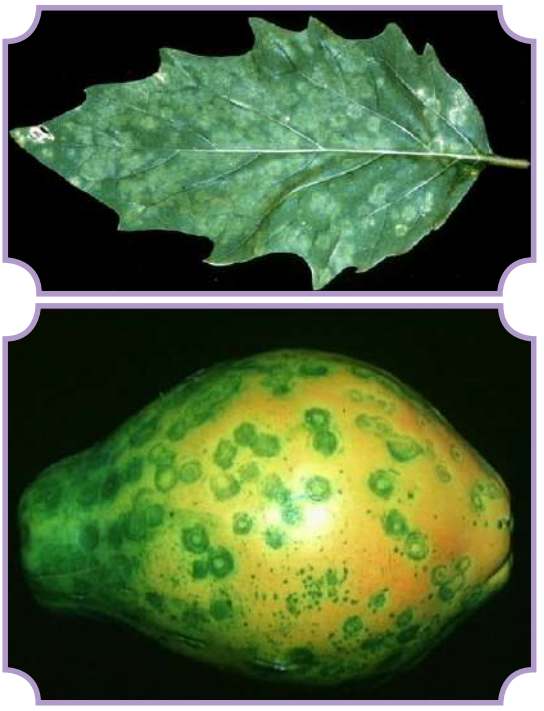


of nucleic acid are nucleotides. Nucleotides are made up of a nitrogenous base, a pentose sugar and a phosphate group combined together. The gene which is the functional unit of the genome exits as two nucleotide chains. Thousands of such genes provide the codes for the production of proteins.

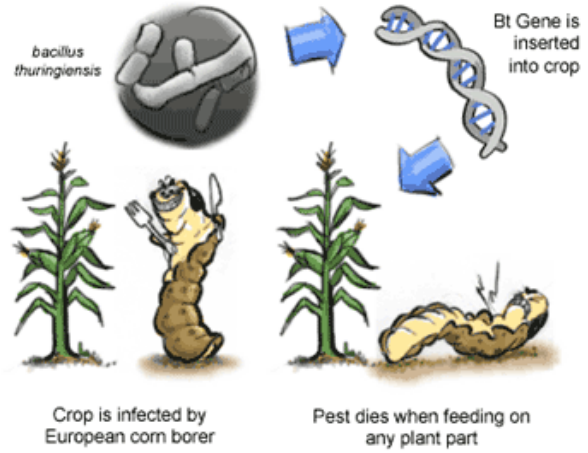
Special Features of DNA

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.

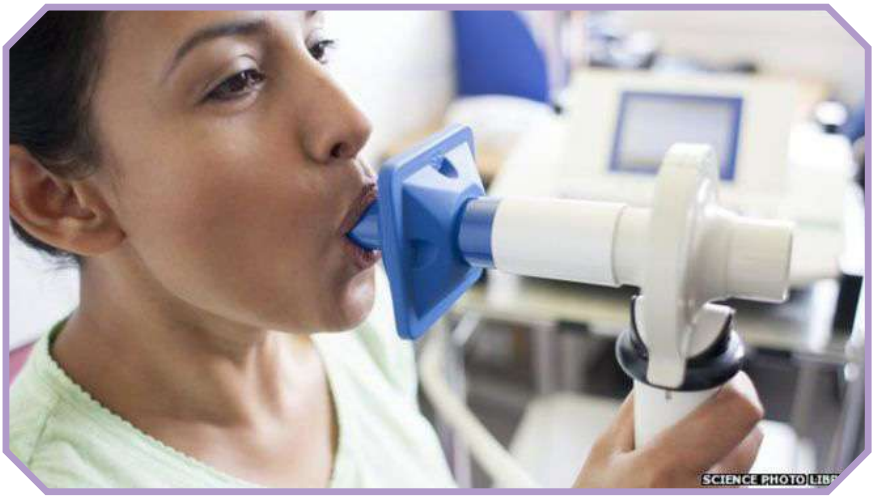
Many of the outcomes or products of biotechnology have been carried out for improvements in the agricultural field. The damage caused by insects to crop plants is a major threat to farmers. One of the main benefits of biotechnology is the production of insect resistant plants in order to prevent such 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

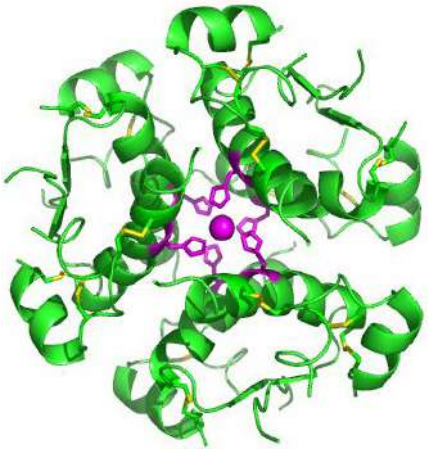


been produced. Other examples are crop plant varieties which can withstand drought conditions, extremes of salinity and extreme cold periods. Cattle which produce a higher yield of milk and meat which are more nutritious and fresh and sheep with more wool are examples of animals produced by gene technology. 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.

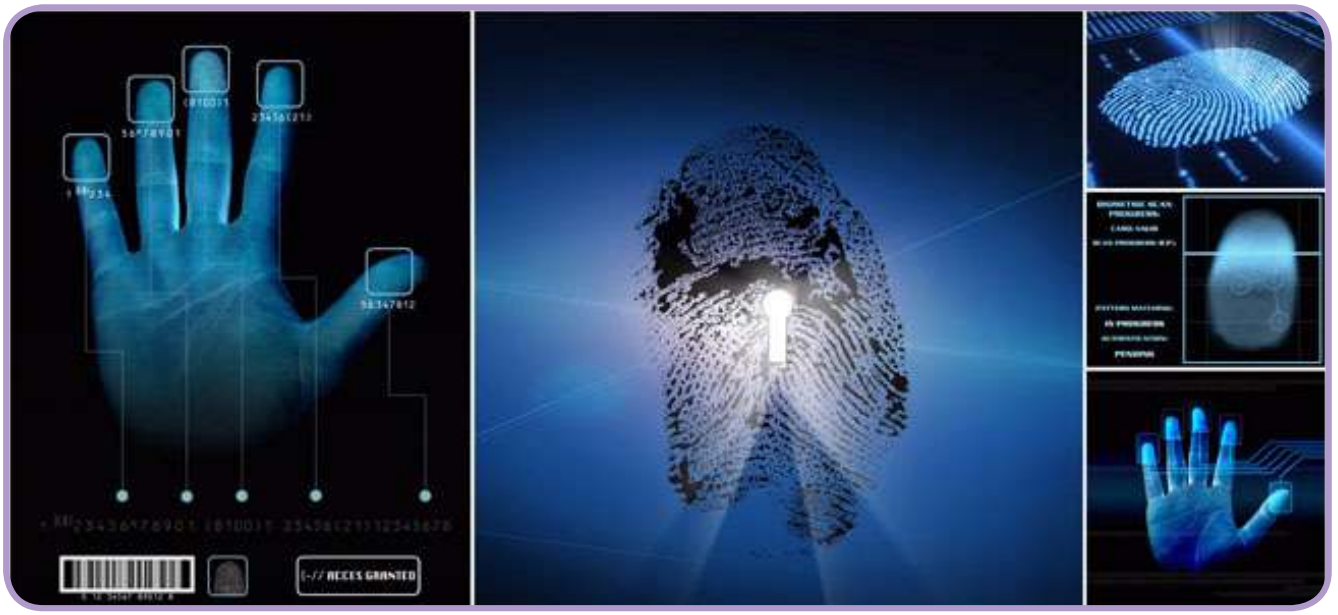
Industrial Sector

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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