Science for Healthy Living

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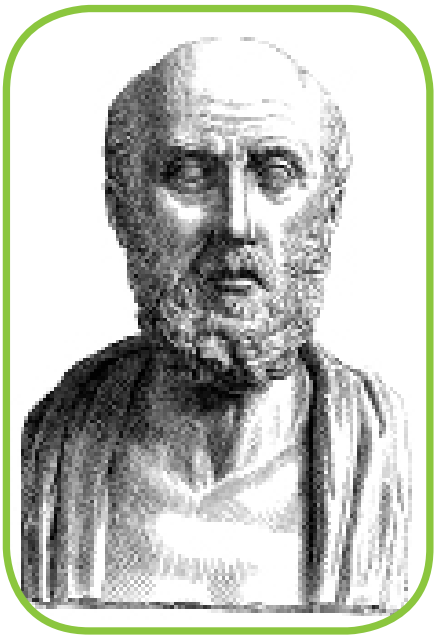
Off the coast of Greece there is a little island called Cos. It would have remained unknown if not for a famous person who once lived there. His name was Hippocrates and he was born around 460 BC. Hippocrates is considered the Father of Scientific Medicine. Why was Hippocrates so honoured? Hippocrates 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.

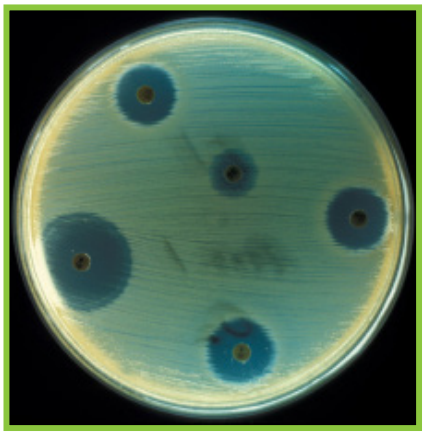
Ignatius Semmelweis was a Hungarian obstetrician who worked

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



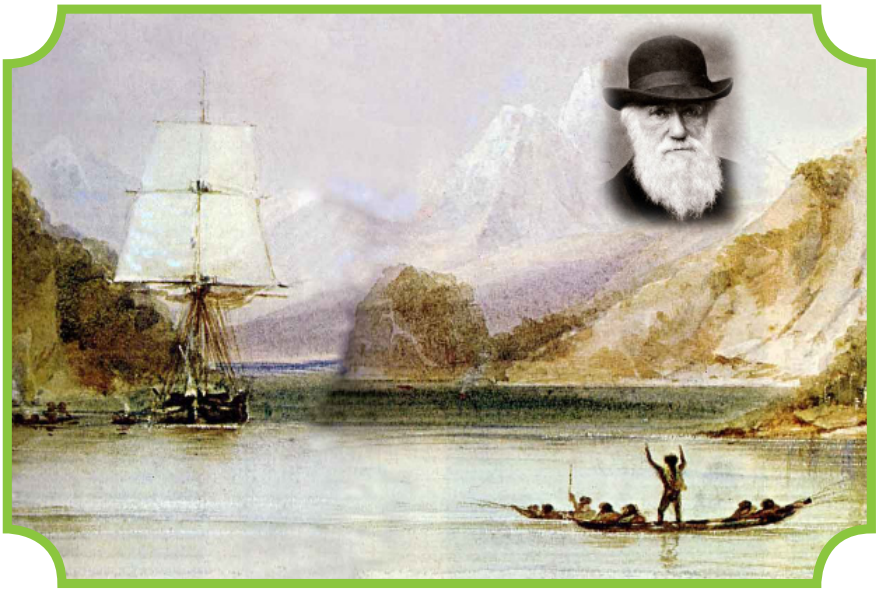
broth and immediately sealed the container it did not spoil but if he added material exposed to the air it turned cloudy. He turned this knowledge to practical use to save the wine industry of France. The wine makers found that their wine was becoming sour and turned to Pasteur for help. He speculated 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.

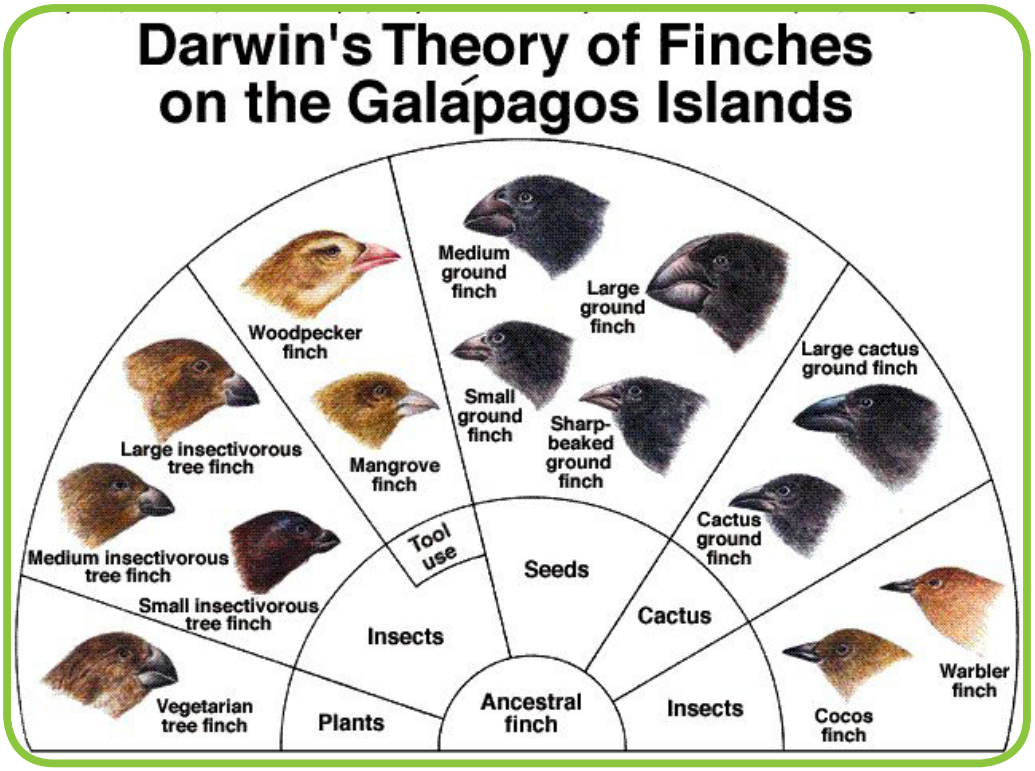
Scientific thinking does not always improve our wellbeing by new discoveries. It also helps us to think about our world in a more rational manner and free ourselves of unnecessary fear. Scientific thinking at times compels us to go beyond the confines of our traditional, cultural and religious beliefs 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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