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Math
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Mathematics of Planet Earth

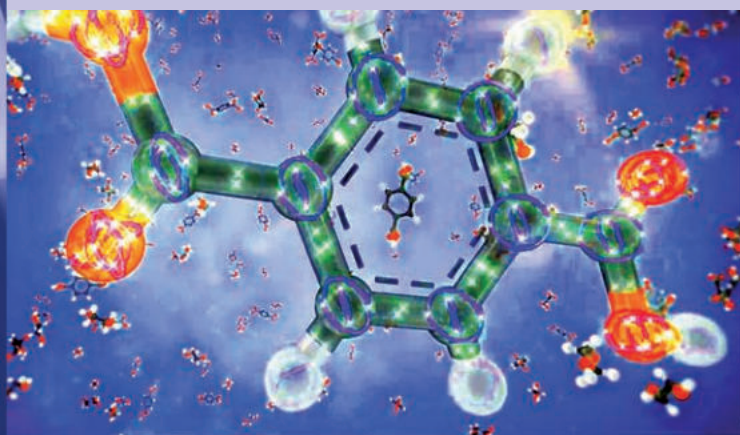
Doing chemistry with computers



Martin Karplus

Arieh Warshel

Michael Levitt



Alfred Lothar Wegener
Founder of the
theory of continental drift



(1880-1930)

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Recent insights from the European Commission on technology communication: Receivers of messages expect clarity of purpose and options



Dr. R. Gopichandran

This editorial is meant to assist eager-to-learn communicators with respect to a framework of science and technology communication/popularisation that goes far beyond changing mindsets and realms of beliefs. The latter can continue to be embroiled in claims and counter-claims of rationality. The framework of the present editorial moves ahead and is centred on a real-life connect with implications for quality of life on tangible economic and sustainability considerations.

Explicit focus on some important parameters of effective technology communication is cited. This could help communicators appropriately adapt and design communication strategies to set a well-informed milieu for citizens to decide on the proposed technology options. The Science & Technology Advisory Council of the European Commission deliberated on the architecture of communication strategies pertaining to “Science for an informed, sustainable and inclusive knowledge society” (August 2013).

The report highlights four important considerations that determine attitudes of citizens to emerging technologies. Receivers of information through communication strategies compare risks, benefits and trade-offs. It is therefore important to establish trust and help citizens visualise: 1) Change and the risks that can be managed by institutions meant to deal with them; 2) Benefits that are direct and immediate for themselves and receivers of related services; 3) Additional options and the freedom to exercise them; 4) Local stake to enhance benefits or modulate spread and depth of activities to sustain benefits; and 5) That there is no hidden agenda or domination that will increase dependence and undermine autonomy.

The Council further argues that welfare of communities is significantly influenced by continual development of scientific knowledge followed by technical assistance with knowhow to derive appropriate benefits from such developments.

Importantly these could create opportunities to tackle societal challenges centred on economic prosperity and related equity. Two additional, interesting and related facets of public response to technology developments are revealed in the cited policy paper. Well endowed segments of the community reportedly do not recognise the need for change. The less endowed segments appear to feel that common good is often compromised and that the advantages are predominantly only for the rich. Complexity of information and pervading uncertainty compound the tendency to suspect the veracity of messages and their intent.

The above stated facets of science and technology communication are arguably relevant even in the Indian context, much as the Council indicates technical innovation, economic competitiveness, social cohesion and environmental resilience as four important streams of convergence to sustain Europe’s progress in the future. This report has also defined the scope to mainstream “practical, experiential, tacit and indigenous knowledge” systems going beyond the rhetoric of rational thinking.

Yet another expression in the report is the “grammar of science”, that has to be weaved into messages meant to stimulate science based thinking. This expression implies the inherent correctness of logic that can be verified and that success is assured when applied without any twists and turns.

[Reference: President Barroso’s Science and Technology Advisory Council, Brussels, 29 August 2013 ‘Science for an informed, sustainable and inclusive knowledge society’; Policy paper. 9p. Accessed on 7 November 2013 http://ec.europa.eu/commission_2010-2014/president/advisorycouncil/documents/stac_policy_paper_no_1_290813.pdf]

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Alfred Lothar Wegener

Founder of the theory of continental drift



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“But the person who has a rightful place in history as ‘father’ of the idea of continental drift, who, unlike other people who speculated about the possibilities, worked out a detailed model—which was not entirely right, but that is besides the point since few models are—and kicked up a fuss about his ideas. Making a positive effort to convert other geologists, instead of just publishing quietly and leaving the theory to sink or swim without help.”

John Gribbin in *Almost Everyone's Guide to Science*, University Press (India) Ltd., 1999

“Wegener is remembered for his theory of continental drift, which he proposed in 1912. Unable to reconcile palaeoclimatic evidence with the present position of the continents, he suggested that originally there had been a single ‘supercontinent’, which he termed Pangaea. He then provided a number of arguments to support the hypothesis that Pangaea had broken up in, Mesozoic times (about 200 million years ago) and that continental drift led to the present continental arrangement.”

The Cambridge Dictionary of Scientists, Cambridge University Press, 2002

“Scientists still do not appear to understand sufficiently that all earth sciences must contribute evidence toward unveiling the state of our planet in earlier times, and that the truth of the matter can only be reached by combing all this evidence...It is only by combing the information furnished by all the earth sciences that we can hope to determine ‘truth’ here, that is to say, to the highest degree of probability. Further, we have to be prepared always for the possibility that each new discovery, no matter what science furnishes may modify the conclusion we draw.”

Alfred Lothar Wegener in *The Origin of Continents and Oceans* (1915)

Alfred Lothar Wegener is a pioneer of Earth systems science. He is mostly known today for his theory of continental drift, which he had proposed in 1912. According to this theory the continents were slowly drifting around. Wegener hypothesised that that in the beginning the continents were merged into a supercontinent, which he called “Urkontinent” in German meaning “origin of the continents”. The word “Urkontinent” was equivalent to the Greek word “Pangaea”, meaning ‘All-Earth’ or ‘All-Lands’. This supercontinent Pangaea was surrounded by a single ocean called Panthalassa (all the sea) before it broke apart more than 2 million years ago, in the late Triassic Period. Earlier, in 1893, Austrian scientist Eduard Suess had proposed the existence of a supercontinent, which he called Gondwanaland after the Gondwana region of central northern India. Gondwana included the present South America, Africa/Arabia, India, Australia and Antarctica and ancient Tethys Ocean. There were others who speculated on the concept of continental drift including Frank Bursley Taylor (1860-1938), an American geologist and Alexander von Humbolt (1769-1859), a German scientist known for his work in physical geography, botanical geography, and climatology. But as noted above, Wegener worked out a detailed model.



Alfred Lothar Wegener

When Wegener proposed his theory of continental drift the geology of many continents was poorly known. Some parts of the Earth were not even examined. The study of oceanic geology had hardly begun. Radioactivity had been discovered, but its implications for geology and tectonics were not discovered. Nothing much was known about the interior of the Earth. Wegener had very limited data with respect to the whole Earth. He had before him enough information about continental geology for a few regions, which accounted for about 10%

of the Earth's surface. Based on this limited information Wegener proposed a theory which encompassed the entire Earth. It was a great mental leap, indeed.

Wegener had developed close relations with the Inuit populations of Denmark and Greenland and he was regarded an authority on Greenland. He was an experienced polar explorer and participated in three scientific expeditions to Greenland. He was a skilled balloonist.

Alfred Lothar Wegener was born on 1 November 1880 in Berlin, Germany. His father, Richard Wegener, was a theologian and teacher of classical languages. Wegener attended school at the Kollnische Gymnasium. He received a PhD degree in astronomy in 1904 from the Berlin University. After his PhD he worked at the Royal Prussian Aeronautical Observatory near Berlin where he used kites and balloons including hot air balloons for studying the upper atmosphere. Wegener and his brother Kurt set a new world record for a continuous balloon flight, remaining aloft more than 52 hours (5-7 April 1906).

In 1906, Wegener participated in the first of his four Greenland expeditions as a meteorologist. It was a Danish expedition and it was led by Ludvig Mylius-Erichsen. The main objective of the expedition

was to study the last unknown portion of the northeastern coast of Greenland. During the expedition Wegener built the first meteorological station in Greenland near Danmarkshavn and he launched kites and tethered balloons to make meteorological measurements in a polar region. He witnessed death of his expedition leader and two of his colleagues who were on an exploratory trip undertaken with sled dogs. He undertook three other Greenland expeditions.

After returning from his first expedition to Greenland in 1908 Wegener worked as lecturer in meteorology, applied astronomy and cosmic physics at the University of Marburg. He impressed his students and colleagues by clarity of his presentation and his ability to explain difficult theoretical concepts in simple terms. In 1911, Wegener compiled his lectures on meteorology in a book titled *The Thermodynamics of the Atmosphere*. It became a standard text throughout Germany.

Wegener had to take part in the First World War and he experienced fierce fighting on the war front in Belgium. However, his stint in the army lasted only a few months as after being wounded twice he was declared unfit for active service. He was posted in the army weather service. It was also not an easy assignment. He had to undertake constant travelling between various weather stations in Germany and other war fronts.

After the War, Wegener succeeded Wladimir Peter Koppen (1846-1940), a German geographer, meteorologist and botanist and his father-in-law as Director of Meteorological Research at the Department of Marine Observatory, Hamburg. In 1924, Wegener joined University of Graz, Austria as Professor of Meteorology and Geophysics.

The idea of continental drift originated in Wegener's mind by noticing that the different large landmasses of the Earth almost fit together like a jigsaw puzzle. In December 1910 Wegener wrote to his future wife: "Doesn't the coast of South America fit exactly against the west coast of Africa, as if they had once been joined? This has an idea I'll have to pursue." At the time



Alexander von Humboldt

it used to be believed that South America and Africa had once been connected by land bridge, but the bridge later got sunk into the sea. Scientific papers were published supporting this belief and authors of these papers cited as evidence fossils of identical animals and which had lived in both the continents in the same period hundreds of millions years ago. After reading such

papers on continental coincidences Wegener got encouraged to pursue his idea that the continents had once been joined.

Wegener first presented his theory of continental drift at a meeting of the German Geological Association held in Frankfurt on 6 January 1912. While rejecting the concept of sunken land bridges, he proposed in his presentation that the continents were drifting. It was a grand vision of the evolution of Earth's geography. Four days after his presentation at Frankfurt he made a similar presentation to the Society of Advancement of Natural Science in Marburg, Germany. Wegener's idea was a revolutionary idea which would later transform geology and completely change our idea about the Earth system. It was completely contrary to contemporary views of the day. At that time geologists were of the view that continents were fixed features which could rise and fall but could not move sideways. They tried to explain all stratigraphy and distribution of fossils by assuming past existence of land bridges and sea ways.

Just two weeks before he made public his theory Wegener had written to Vladimir Koppen, an eminent climatologist, who later became his father-in-law: "if it turns out that sense and meaning are now becoming evident in the whole history of the Earth's development, why should we hesitate to toss the old views overboard."

In 1915, Wegener presented his theory in detail in his book *Die Entstehung der Kontinente und Ozeane (The Origin of Continents and Oceans)*. Through this book, as his brother Kurt remarked, Wegener wanted "to re-establish the connection between geophysics on the one hand and

geography and geology on the other, which had become completely ruptured because of the specialised development of these branches of science." The book was translated into English in 1926.

Wegener tried to advance a number of mechanisms for his proposed continental drift. He argued that the rotation of the Earth created a centrifugal force towards the equator. According to Wegener, Pangaea was formed near the South Pole and the centrifugal force of the planet not only broke apart the supercontinent but also made the resulting continents to drift towards the equator. However, on calculating the actual force generated by the rotation of the planet, scientists found that it was not sufficient to actually move the continents. So scientists rejected Wegener's idea about the role played by the force generated by the rotation of the Earth. Wegener thought that the westward drift of the American continents was caused by the gravitational force of the Sun and the Moon. However, this idea was also rejected soon.



Arthur Holmes

Arthur Holmes (1890-1965), a British geologist, made an attempt to advance Wegener's idea that the mantle undergoes thermal convection. The basis of this idea was the fact that when Earth's mantle is heated up its density decreases and rises to the surface but in the process it is cooled and sinks again. This repeated heating and cooling

results in a current that may cause the continents to drift. Holmes compared the thermal convection to a conveyor belt. He thought that the upwelling pressure could break apart a continent and the broken parts would be moved in opposite directions by convection currents. Holmes's idea also failed to draw the attention of geologists. But it became clear that Holmes was after all right that it is due to convection currents. By that time convection currents in Earth's mantle had been proven to be a reality after scientists gained greater knowledge of the ocean floor and discovered features like mid-oceanic ridges, geomagnetic anomalies parallel to the mid-oceanic ridges, and the association of island arcs and oceanic trenches occurring together. The idea of Holmes was revived by Harry Hammond Hess (1906-1969), an American geologist and Robert S. Dietz (1914-1995), an American geologist,



Wladimir Peter Koppen

geophysicist and oceanographer with more credible evidence provided by the new discoveries.

Wegener's theory of continental drift provided an alternative explanation for mountain formation or orogenesis. The existing theory for explaining mountain formation at the time of Wegener was called contraction theory. The contraction theory



Harry H. Hess

assumed that planet Earth was once a molten ball and as it cooled the surface cracked and folded up on itself. The major problem with this theory was that it could not explain the fact that different mountain ranges are of different ages. If the contraction theory was true then all mountain ranges should be approximately the same age. Wegener's theory could overcome this problem. Wegener suggested that as the continents drifted, the leading edge of a continent would encounter resistance. As the result of resistance faced the continent would compress and fold upwards to form mountains. So, according to Wegener, mountain ranges would form near the leading edges of the drifting continents. In support of his assertion Wegener cited the examples of Sierra Nevada Mountains on the Pacific coast of North America and the Andes on the coast of South America. Wegener also suggested that the Himalayas formed as the Indian landmass drifted toward the Asian continent.

Wegener's theory was not widely accepted until 1950s. In his lifetime, Wegener was primarily known for his contributions to meteorology and as a pioneer of polar research. Wegener's ideas were ridiculed. It should be noted that all new scientific theories are initially viewed with scepticism and so Wegener's idea was no exception. However, it should also be mentioned that the debate on Wegener's theory was harsher than usual. So there is no wonder that some people also compared Wegener's suffering at the hands of his opponents to that of Galileo, who supported the Copernican heliocentric theory of the Solar System.

There were many reasons why Wegener's idea was not immediately accepted. One of the reasons might be that Wegener proposed his theory shortly after the start of the First World War and the scientists were occupied with the war effort. But the main reason for the delay in accepting Wegener's theory was that there was no evidence to indicate that the

continents could actually move. When sufficient experimental evidence in support of Wegener's theory came to the fore the theory was accepted universally.

Wegener's idea is not simply of historical importance. It is not only relevant today but it forms the basis of the modern science of Earth's systems including climate science. The underlying

mechanism behind continental drift is now called 'plate tectonics'. The main features of plate tectonics are:

- The Earth's surface is made up of large crustal plates, also called tectonic plates.
- The plates making up the Earth's surface are in constant motion, albeit very slowly.
- The ocean floors are in constant motion, spreading from the centre and sinking at the edges.
- The plates are driven in different directions by the convection currents operating beneath them.
- The heat which generates the convection currents is the result of radioactive decay taking place deep inside the Earth.
- The edges of the plates are sites of intense geologic activity, resulting in earthquakes, volcanoes, and mountain formation.

Plate tectonics plays an instrumental role in maintain life on Earth by maintain a concentration of carbon dioxide in the atmosphere sufficient for plant photosynthesis. This happens because of the flow of matter from the crust and back. However, the regulation mechanism is too slow to take care of huge emissions by human activities.

Alfred Wegener got the recognition which he so eminently deserved. However, as it was case with many other visionaries it was a posthumous recognition. The exact date of his death is not known, but it is known that he died in November 1930 at Clarinetania, Greenland. He had gone to the Greenland as leader of a 21-member team of scientists and technicians. His aim was to study the great ice cap and its climate. To realise his objective he planned to establish three observation posts: one on the western edge of the ice, one on the eastern edge, and one at mid-ice. However, he did not survive

to realise his objective. He succumbed to the extreme weather a few days after his 50th birthday. On his birth centenary in 1980, the Alfred Wegener Institute for Polar and Marine Research in Bremerhaven, Germany was established. The Institute has established an award (the Wegener medal) in honour of Wegener. A Moon crater, a Mars crater, and an asteroid have been named after Wegener. The peninsula where he died in Greenland has been named after Wegener. The European Geosciences Union sponsors an Alfred Wegener Medal and Fellowship "for scientists who have achieved exceptional international standing in atmospheric, hydrological or ocean studies, defined in their widest senses, for their merit and their scientific achievements."

Two important books on life and work of Alfred Wegener are: *Alfred Wegener: The Father of Continental Drift* by Martin Schwarzbach (1986) and *Greenland Journey: The Story of Wegener German Expedition in 1930-31 as told by the Members of the Expedition and the Leader's Diary*, edited by Else Wegener and Fritz Loewe (1939).

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(The article is a popular presentation of the important points on the life and work of Alfred Lothar Wegener available in the existing literature. The idea is to inspire the younger generation to know more about Alfred Lothar Wegener. The sources consulted for writing this article have been listed. However, the sources on the Internet have not been individually listed. The author is grateful to all those authors whose writings have contributed to writing this article. The author is also grateful to the sources from which the illustrations/photographs have been reproduced).

Doing chemistry with computers



Biman Basu

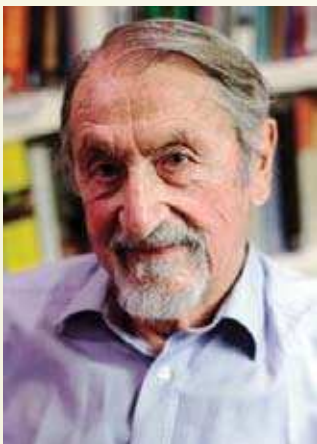
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Chemistry is the branch of science concerned with the substances of which matter is composed, the investigation of their properties and reactions, and the use of such reactions to make new substances. Chemistry tends to focus on the properties of substances and the interactions between different types of matter, particularly reactions that involve electrons.

Understanding chemistry helps us understand the world around us. For example, cooking is chemistry. Everything that we can taste or smell is a chemical. Almost everything that we use daily – right from moment we get up in the morning till we go to bed at night – are intimately related to chemistry. The toothpaste we use to clean our teeth, the toilet soap, shampoo, and plastic buckets we use at bath, the plastic comb we use to comb our hair, the melamine cups and plates we use at breakfast, the cooking gas we use in the kitchen, the iodised salt we use to cook food, the ink in the pen we write with, the inks this magazine is printed with, the beautiful dyes that brighten up our dresses, the polyurethane foam mattress that makes our sleep at night comfortable, and a host of other items of daily use are all products of chemistry.

And there cannot be chemistry without chemical reactions, which turns a set of reactants into a different set of products. For example, when baking powder (sodium bicarbonate) is added to vinegar (acetic acid), a chemical reaction takes place leading to the production of sodium acetate and evolution of carbon dioxide, which escapes as bubbles.

Most chemical changes happen when exchange of



Martin Karplus

electrons takes place between atoms and molecules and bonds are broken and formed between atoms. But the details of a chemical reaction are virtually impossible to map using traditional methods of chemistry. All chemical reactions occur at lightning speed as electrons jump between atoms, making it virtually impossible to map every separate step in chemical processes, especially in reactions involving large molecules like

proteins. Many things happen in a fraction of a millisecond (one thousandth of a second) – a rate that is too fast to study using test tube experiments.

But things have changed. It is now possible to study fast chemical reactions using powerful computer programmes, first developed by the three American theoretical chemists who have been jointly awarded the 2013 Nobel Prize for Chemistry. The work of the three scientists – Martin Karplus of the University of Strasbourg, France, and Harvard University, USA; Michael Levitt of Stanford University School of Medicine, USA; and Arieh



Arieh Warshel

Warshel of the University of Southern California, USA – offer a new window onto chemical reactions and have become a mainstay for researchers in thousands of academic and industrial laboratories around the world. The three scientists have been awarded this year's prize in recognition of their "pioneering work on computer programs that simulate complex chemical processes and have

revolutionised research in areas from drugs to solar energy."

In reactions involving large molecules such as proteins the shape of the molecule plays a key role in deciding the nature of the chemical reactions that the molecule can undergo. Before computers became available, chemists used to create models of molecules using plastic balls and sticks to understand how they function. A classic example is the ball-and-stick model of the DNA molecule built by James Watson and Francis Crick that in one stroke explained how the DNA molecule functions to carry hereditary information and also got Watson



Michael Levitt

and Crick the Nobel Prize in Physiology or Medicine in 1962. Today, chemists are able to do the modelling on computers with the help of powerful programmes based on foundations laid by this year's Nobel trio, which can be used to understand and predict chemical reactions. Computer models have become crucial for most advances made in chemistry today. For

designing drugs, scientists now routinely use computers to find out how an experimental medicine would react with a particular target protein in the body by working out the interaction between atoms.

The first attempts at using computer to study chemistry were made in the early 1970s when some of the early quantum-mechanical computer simulations were tried out by Karplus, who led a research group at Harvard University in USA. Levitt and Warshel, meanwhile, had been working on a Newtonian program at the Weizmann Institute of Science, in Israel, which was capable of handling even large biological

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Chemistry in Human Evolution, Sustenance and Survival



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Among the diverse fields of science, chemistry plays the key role in determining the nature of the modern world. Though by definition, chemistry is the science of matter which undergoes changes, in reality, chemistry goes beyond its traditional definitions. From the evolution of mankind itself, chemistry has had a close connection with the daily acts of human beings. Every matter is related to chemistry; even we, the human beings are made of chemicals.

Chemistry – Lifeline of the universe

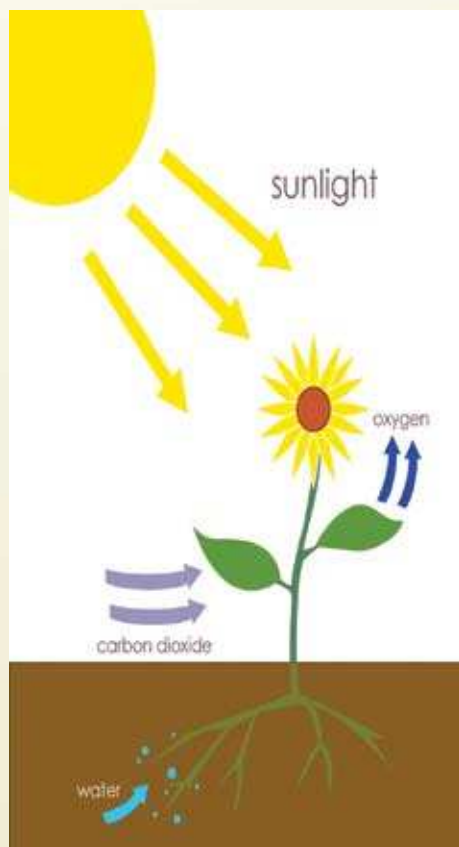
Chemistry is responsible for creating and sustaining life on Earth, and is a key science of the future. All the substances that we see around us – rocks, plants, water, air and everything else is a product of chemistry. The



Colour of flowers is due to organic chemical molecules



*Polymer-based CD/DVD
(Credit: Wikipedia)*



Photosynthesis (Credit: Wikipedia)

chemistry of photosynthesis in plants creates food out of carbon dioxide and water. Plants fix the carbon dioxide from air to produce food and oxygen for us. The Amazon forest alone produces 15% of oxygen on Earth. Biosynthesis in plants and animals creates many complex molecules that sustain the life. Oxygen generation and the fixation of nitrogen and carbon dioxide are done by chemical processes in plants. Water is our lifeline. The chemical reactions in all plants and animals that support life take place in a water medium.

Chemical processes occurring in the atmosphere render it conducive for life. Plants synthesise organic pigments (anthocyanins, flavones, etc.) to make flowers colourful. Perfumes are organic molecules synthesised by plants.

What would the world be without chemistry!

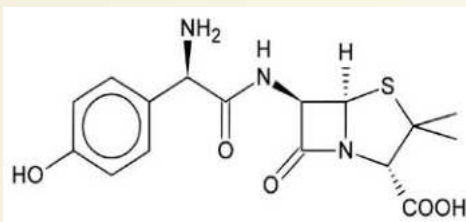
Chemistry gives colour and fragrance to life not only through plants, but through many other ways. Here are some of the things that would not have been possible without chemistry. No plastic means no plastic bags, no CDs or DVDs, no iPods, no plastic ware and furniture, no scotch tape, and no synthetic fabrics. No parts of your car would be made of plastic to make it lightweight. There would also be no gasoline, no aircraft, no modern pharmaceuticals, no pain killers! No water purification and no sewage treatment using chemistry. No glues, no synthetic fertilisers and insecticides, no green revolution. Farming and food production wouldn't be nearly as productive and starvation would have been a massive problem.

There would also be no microcircuits through photo lithography and hence no compact televisions, radios or computers. No batteries, no cell phone! The list is almost endless.

You probably wouldn't be alive were it not for chemistry. Trillions of chemical reactions that happen every second in your body keep you alive (and sane!). Chemistry doesn't make our lives easier, it makes them possible. Application of chemistry has widely helped the growth of medicinal and pharmaceutical chemistry and paved the way for the development of drugs and artificial body implants. But for chemists, medicines for diseases right from common cold to



Medicine tablets (Credit: Wikipedia)



The antibiotic Amoxicillin is a complex organic molecule

deadly cancer would not have emerged. The antibiotics that save our lives are complex organic molecules – products of chemistry.

Role of polymer chemistry

Polymer chemistry is an integral part of chemistry and hence of our life. Polymers have benefited our society in a number of ways. Polymers have helped aerospace technology take giant steps forward over the past 50 years, including advancements in satellites, shuttles, aircraft, and missiles. As a result, civilian air travel has improved, along with military air power and space exploration. In addition, the building and construction, electronics, packaging, and transportation industries have all benefited greatly from polymers. In fact, nearly all modern homes use polymer as electrical insulators, connectors, switches, and receptacles. Polymers are indispensable for making small appliances, food processors, microwave ovens, mixers, coffee makers, shavers, irons, and hair dryers, and what not! Computers as we know them today would probably not exist without polymers. Components such as circuit boards and computer chips are possible to be miniaturised thanks to the use of polymers. Without polymers such as rubber and nylon, vehicles would have to be fitted with wooden tyres like bullock carts!

Chemistry in space applications

The great contribution of chemistry to space research is the development of synthesis processes for propellants and oxidisers like ammonium perchlorate, strontium perchlorate, nitrogen tetroxide and fuels like hydrazine and its derivatives. The solid propellants are also chemicals. The liquefaction of oxygen and hydrogen has made the use of cryo-technology in rockets possible.

The different types of battery systems powering the satellites, the emerging fuel cell

technology, etc., are other examples of use of chemistry in space technology. The great advancements in high-performance polymers and polymer-based systems were derived to a large extent from the exacting demands of the aerospace industry. Exotic materials developed with innovative technologies and their judicious combinations satisfy the high and conflicting demands of the aerospace such as high strength and low weight,



Satellite launch vehicle (PSLV)

ability to withstand hard vacuum and hostile environment of very low and high temperatures, UV and particle radiation, etc.

Among the host of polymers traditionally used in launch vehicles, the most important class of polymers is the polymeric fuel binder for composite solid propellants. Diverse polymeric systems used in space application include polymers and composites for structural applications, thermal protection systems for cryogenic temperatures to re-entry conditions, coatings, adhesives, sealants, etc. When it concerns recovery of satellites from space, the extreme heat flux encountered calls for use of high heat flux dissipating ablatives such as thermal tiles used in space shuttle. Since launch vehicles and satellite structures consist of a number of dissimilar materials, different polymer adhesives are used for joining them. Specially structured polymers

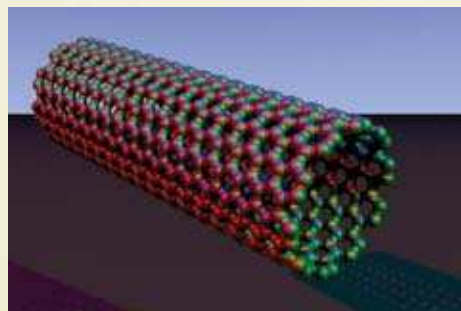
only can sustain the cryo-temperature for cryo-engines. Polymer adhesives joining satellite components are meant to withstand the hostile environments of vacuum, thermal cycling, space radiation and these pose great challenges to chemists. Organic/polymer materials specially developed for space use include fire-resistant polybenzimidazole, impact-resistant polycarbonate, radiation protective ultrahigh molecular weight polyethylene, super absorbing acrylic polymers, moisture permeable membranes and copolymers for space suits.

Smart chemistry

A combination of smart/intelligent material and nanotechnology can revolutionise future aerospace research. Intelligent polymers have the capability to respond physically to external stimuli such as temperature, light, solvent, pH, electric and magnetic fields, etc. These are being explored for their possible applications in self-deployable systems, sensors, actuators, switches, and memory devices, etc. Large structures can be transported to space in the compact form and deployed in space by heating. Damage in the form of a crack serves as the triggering mechanism for self-healing materials as does the fracture event in biological systems. The supramolecular self-healing rubber can be processed, re-used, and recycled. The smart polymer works on principle of hydrogen bonds that establish simply by pressing the two faces of a substance together. This technology can be used to mend micro-cracks developed in aerospace structures.

Nanochemistry

Nanotechnology can revolutionise material science because many physical and chemical properties of materials change significantly in the nano regime, which can be controlled and tuned to make many useful products and



Representation of a single-wall carbon nanotube (Credit: Wikipedia)



Organic-solar cell driven vehicle (Credit: Wikipedia)

devices. With superior, lightweight materials realised through nanotechnology, which are several times stronger than steel at a fraction of its weight, the efficiency, reliability and performance of tanks, airframes, spacecraft, skyscrapers, bridges, etc., can be increased multi-fold. Healthcare is an area where nanotechnology has direct impact on mankind. Faster, cheaper and portable diagnostic equipment will be realised. Controlled drug delivery has already utilised the concept of nanotechnology where the right amount of medicine is delivered to the exact spots of the body required. By having lighter and stronger engine blocks and frames based on nanocomposites, the fuel efficiency of automobiles can be improved significantly. Nanomaterials like carbon nanotubes, graphene, nanoclay, etc., are said to increase the strength of material at minimal loading.

Super-hydrophobic nano materials will serve as self-cleansing systems in related areas of application. Efficient water purification techniques are also possible. Nanotechnology offers benefits to space technology in terms of weight reduction, size reduction and improved capabilities. nano polymer composites can withstand the harsh space environment. Unlike traditional filled polymer systems, nano composites require relatively low dispersant loadings to achieve significant property enhancements. In space systems, physical properties like permeability, oxidation and atomic oxygen resistance; electrical properties such as electrostatic charge mitigation, electromagnetic interference; thermal properties like thermal conductivity and coefficient of thermal expansion and mechanical properties can be modified or improved by the concept of nanotechnology. Recent advances in plastics

and nanotechnology are speeding up the development of flexible hybrid solar cells that involves an inorganic semiconductor and an organic polymer with higher efficiency.

The other side of chemistry

As there are two sides of a coin. Chemistry, if not properly used, can become the cause of the 'death carrier' of the planet that we live in. No chemistry means no bullets, no explosives, no N-weapons, no chemical war, no narcotics, no Bhopal gas tragedy, no 9/11 attacks, and no endosulfan. Nuclear energy can be used both for power generation and for building nuclear weapons. Anthropological chemical activities have caused depletion in the ozone layer. Global warming caused by greenhouse gases is another concern.

Nevertheless, the pros of chemistry far outweigh the cons. The famous playwright

Nobel Laureate, "It is impossible to deny that chemistry has played a major part in determining the nature of the modern world and it will continue to do so in the future"

Future of chemistry

Future of chemistry lies in chemist's capability in addressing issues like:

- Making chemical processes economical, safe, energy-efficient and environmentally benign.
- Making greater use of solar energy. It should be possible in future to synthesise food, fuel and materials from carbon dioxide, nitrogen and oxygen along with sea water, in solar reactors.
- Using fuel derived from biomass and production of biodegradable plastic materials using natural sources.
- Making chemistry go green; replacing undesirable chemicals by green and sustainable chemicals.
- Encouraging innovative research for cheaper synthesis of pharmaceuticals to combat diseases that grow.



Green chemistry - means and avenues

George Bernard Shaw once quipped: 'Science is always wrong. It never solves a problem without creating ten more'. Being a branch of science, chemistry may also have to bear the brunt of this criticism. In essence, it only implies the ever expanding field of research. But the history of chemistry shows that there are instances of great successes leading to more number of successes.

To quote Linus Pauling, double

In brief, 'future chemistry' beckons humanity with hopes of greater understanding of nature and greater welfare of mankind.

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Snakebite: First Aid, Diagnosis and Treatment



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According to WHO estimates India has the highest number of snakebite deaths which is around 50,000 every year. In 2009, snake-bite was included in the WHO's list of neglected tropical diseases which remains a common occupational hazard of farmers and field workers causing deaths and chronic physical handicap. Among approximately 3,000 species of snakes found worldwide, only 15% are considered dangerous to humans.

In India snakebite is predominantly a problem of rural and semi-urban areas and the fatalities are mainly due to the delayed arrival of the victim to the hospital. Precious time is lost in folk medication and traditional practices to treat the bite. Obviously the rural community is still not well informed about the occupational risks and simple measures that can prevent snakebite deaths. People at large still continue to adopt harmful practices such as tourniquets, cutting and suction, herbal remedies, quackery, etc., which are not only ineffective but many times dangerous too. Also doctors at primary health centres avoid treating snakebite patients mainly due to the lack of confidence. Health and Family Welfare Department of Government of India therefore prepared a 'National Snakebite Management Protocol' (NSMP) in 2007 to provide doctors and lay people (online) with the best evidence based approach to dealing with snakebite in India. WHO has also prescribed a detailed guideline to save the snakebite patients (also available online).



Present article highlights the salient features of both these guidelines.

An occupational risk

People think that snakebites usually occur in the morning and at night. But this is not true as snakes may bite at any time of the day depending on certain human activities. For example, grass-cutting remains a major situational source of snakebites. In rubber and coconut plantations a large numbers of bites often occur during clearing of the base of the trees to stock manure.. Activities like harvesting high growing crops like millet which necessitate attention focussed away from the ground. Rubber tapping in the early hours (3:00-6:00 a.m.), vegetable harvesting/ fruit picking, and activities in tea and coffee plantation enhance the risk of arboreal and terrestrial viper bites. Clearing of weeds, grass-cutting, walking barefoot at night without a torch and wearing sandals with a large area of feet exposed account for a significant number of snakebites. Also, bathing in ponds, streams and rivers, especially in the evening poses risk of snake encounters as cobras and other venomous species are good swimmers and may enter the water to catch their prey. One should also be careful while walking on the edge of waterways.



How to avert encounters with snakes and avoid being bitten!

While walking at night or during an evening stroll, especially in rainy season, one should use sturdy footwear and also use a torch. Walking should deliberately be done with heavy steps as snakes can detect ground-borne vibrations and will slither away. When cleaning the lawn or engaging in garden grass cutting or picking fruits or vegetables, or even clearing the base of trees, one should use a long stick to move the grass or leaves first so that any snake present there gets a chance to move away from the place. Some crops like millet are often harvested at head height while losing concentration away from the ground. Here one should be very cautious and pay close attention periodically to the ground also. Animal feeds and rubbish, unused building materials should be kept away from the house premises. Food items usually attract rodents and snakes enter the premises while following them. Sleeping should be avoided on the ground. Plants, especially creepers should be raised away from doors and windows. Snakes like such hiding places and may climb up and into windows.

The first aid

The first and foremost aid is to reassure the patient because 70% of all snakebites are from non-venomous species. And even in venomous snakebites only 50% of bites actually inject the venom into the patients.



After assuring patient the bitten part needs to be immobilised in the same way as a fractured limb. Bandages or cloths may be used to hold the splints, but without blocking the blood supply or applying too much pressure. Compression in the form of tight ligatures should not be applied because they don't work and can be dangerous! It is better to transfer the patient immediately to hospital immediately, as traditional remedies have no proven benefit in treating snakebite. The doctor should be told of any systemic symptoms, such as droopiness of a body part which manifest on the way to hospital.

The National Snakebite Management Protocol (NSMP) has also emphasised that the prevalent common methods such as tourniquets, cutting and suction and herbal remedies are not only completely ineffective but dangerous also and hence have been proscribed. A new strategy has been recommended instead. It is called the 'Do it R.I.G.H.T.' approach and stresses the need for *Reassurance*, *Immobilisation* as per a fractured limb, *Getting to Hospital* without delay, and *Telling* the doctor of any symptoms that develop.

Symptoms and diagnosis

Common symptoms of snakebites whether poisonous or not are overwhelming fear, panic, and emotional instability, which may cause symptoms such as nausea and vomiting, diarrhoea, cold, etc. Our media, television and folklore literature are mainly responsible for the hype surrounding snakebites, and people may have unwarranted fears of imminent death. Cobra and Krait bites contain toxins which attack the nervous system, causing neurotoxicity. The victim may experience blurred vision, a burning sensation throughout the body, numbness in limbs as well as difficulty in speaking and breathing, which may be the prominent symptoms. If not treated immediately they may die from respiratory failure. The venom of vipers are, however, haemotoxic (destroy blood cells) and may have initial symptoms of lethargy, bleeding, weakness, nausea, and vomiting.

Identification of the snake is considered important in planning a treatment schedule in certain areas of the world, but is not always possible. The dead snake could be brought in with the bitten person, but in



areas where snakebite is more common, local knowledge may be sufficient to recognise the snake. However, in regions where polyvalent anti-venom is available, such as in India, identification of the snake is not necessary. Also, attempting to catch or kill the snake after it has bitten someone is dangerous and may put one at risk and a second person may also be bitten. Therefore any such attempt is not recommended.

Only the venomous snakes which are

members of the "Big four" (viz., cobra, krait, Russell's viper and Saw-scaled viper) cause the majority of major clinical problems in India. Knowledge of what species are present locally can be crucial, as is knowledge of typical signs and symptoms of a bite from the above mentioned snakes.

However, bite marks and certain symptoms other than the cobra in eastern U.P. are not sufficient for identification if a species is venomous or not. Other identification clues like swellings, etc., must be taken into consideration. Even non-venomous species like Wolf snakes leave just two fang-like marks. Krait may leave no bite mark at all. Cases of venomous snakes with more than two fangs have also been reported as they grow reserve fangs in case the main ones break off.

Exact time of bite may be determined which can give indications as to the progression of symptoms. Some activities such as grass cutting or feeding stock animals

Snakebite: Some don'ts!

The following treatments once recommended are now considered of no use or even harmful and include: tourniquets, incisions, suction, application of cold, and application of electricity. Cases in which these treatments appear to work may be of a non-poisonous bite or a 'dry bite' by even a poisonous snake where no injection of venom takes place at all.

- Application of a tourniquet to the bitten limb is not recommended as there is growing and convincing evidence that it is not an effective first aid tool. Moreover uninformed tourniquet may be dangerous, since reducing or cutting off circulation can lead to gangrene which can be fatal.
- Cutting open the bitten area is also not recommended since it causes further damage and increases the risk of infection.
- Sucking out venom as shown often in Hindi movies by mouth does not work and may harm the affected area directly. It may be even dangerous to the person who sucks the wound if his/her mouth has sores and cuts. Suctioning by mouth presents a risk of poisoning even through the mouth's mucous tissues. The method may also release bacteria from the mouth into the bitten persons wound, leading to infection.
- Immersion in warm water or sour milk, followed by the application of folk methods of applying snake stones are believed to draw off the poison in much the way a sponge soaks up water, but these are not effective.
- Application of 'laal dawa', i.e., potassium permanganate is also not effective treatment.
- Electroshock therapy in animal tests has shown this treatment to be useless and even potentially dangerous.
- In worst cases in remote areas, all above and many other misguided attempts of treatment have only resulted in injuries far worse than an otherwise mild to moderate snake bite. Best course of action is to take patient to nearest PHC as soon as possible for AVS treatment.

in the evening can expose one to snakebite. Therefore ask question what the victim was doing at the time of the bite. Such queries may be crucial in judging a venomous or non-venomous bite. If it is a venomous snakebite patient may be experiencing mild to severe pain also at the bitten part.

Pain

Snakebite can often cause severe pain at the bitten part. This can be treated with popular pain killers like Paracetamol, 500 mg tablets (adult), available over the counter at most medicine shops. But aspirin is not to be used because it may have an adverse impact on blood coagulation. Non-steroidal anti-inflammatory drugs (NSAIDs) should also be not used as they can cause bleeding. This can be particularly dangerous in a patient already having coagulation problems. However, opiates such as Tramadol (50 mg) can be used orally for relief of severe pain.

Use of anti-snake venom (ASV)

Anti-venom is injected into the person intravenously and works by binding to and neutralising venom enzymes. Anti-venom treatment should be sought as soon as possible as it cannot undo damage already caused by venom. In India anti-venom available at primary health centres (PHC's) is polyvalent, making it effective against the venom of all 'the big four' poisonous snake species. Although some people may develop serious adverse reactions to anti-venom, such as an anaphylactic shock (a serious allergic reaction) but in emergency situations this is usually treatable and hence the benefit outweighs the potential consequences of not using anti-venom. Anti-snake venom is only surest remedy for the bite of a poisonous snake. Its freeze-dried powdered form has a shelf life of 5 years, but needs to be protected from direct sunlight. Its liquid form is easier to administer but has a shelf life of two years only and requires constant refrigeration.

The hormone adrenaline (epinephrine) is the most effective treatment for severe allergic reactions; it reduces by reducing asthma-like attacks. Adult dosage of 0.5 mg of 1:1000 with a potential of three doses maximum per patient has been recommended. If a case history of a patient reveals that he/she has already reacted to horse (equine) serum in the past (for example, after treatment with equine anti-



tetanus serum, equine anti-rabies serum or equine anti-venom) or the patient has had a strong history of atopic diseases (especially severe asthma), they may be at high risk of severe reactions and should therefore be given anti-venom only if they have signs of systemic poisoning by venom. High-risk patients may be pre-treated empirically with subcutaneous epinephrine (adrenaline) and intravenous antihistamines.

Snakebite treatment protocol at PHC's

Question often arises what quantity of anti-snake venom is sufficient to be kept at any primary health centre? The holding quantity can be established using the following equation:

$$(xd \times 1.2)t$$

Where:

x = number of average poisonous snake bites brought to PHC per month.

d = the maximum number of vials likely to be applied at the PHC to a single patient.

t = time required for replenishment of stock in months.

1.2 = the safety factor to ensure greater than minimal stock is available.

For example, suppose we are dealing with a PHC with two snakebite cases a month then $x=2$. The maximum dose required per patient remains 2 split doses of 10 vials for a neurotoxic poisoning as in Cobra and Krait bite and therefore d is here 20.

If the re-stocking period is 2 months for anti-snake venom then t would be 2 and hence a PHC located in any affected area would require $2 \times 20 \times 1.2 \times 2 = 96$ vials of

anti-snake venom to be kept as base stock amount.

Treatment procedure (NSMP recommendation)

If the patient shows signs of neurotoxic poisoning, for example due to cobra and/or krait bite, 8-10 vials of SAV should be administered over 1 hour. Adrenaline is made ready in two syringes of 0.5mg 1:1000 for intramuscular (IM) administration if symptoms of any adverse reaction appear. If symptoms do appear, ASV is temporarily suspended while the reaction is dealt with and then recommenced. If after 1 hour from the end of the first dose of ASV, the patient's symptoms worsen; i.e., paralysis progresses further, a second full dose of ASV is given over 1 hour. ASV is then completed for this patient. If after 2 hours the patient has not shown worsening of symptoms, but has not improved; a second dose of ASV is given over 1 hour. Again ASV is now completed for this patient.

A key objective of National Snakebite Management Protocol is to enable doctors posted in PHC's to treat snakebite with confidence. It was felt for long that even when equipped with anti snake venom, Primary Care doctors lacked the confidence to treat snakebite due to the absence of a protocol tailored to their needs and outlining how they should proceed within their context and setting. Now with the availability of such a protocol it is expected that number of snakebite deaths would come down appreciably.

Further reading

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Multiple sclerosis— All you want to know about



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Multiple sclerosis – call it by the acronym MS if you will – is a common nervous system disease that develops usually between early adulthood and middle age. In this condition, the nerves in the brain and spinal cord are progressively affected, causing a wide range of symptoms that affect sensation, movement, body functions, and balance.



Symptoms vary widely, depending on the amount of damage and the nerves that are affected. Specific symptoms relate to the particular areas that are damaged and vary in severity between different people. For example, damage of the optic nerve may cause blurred vision. If nerve fibres in the spinal cord are affected, it may cause weakness and heaviness in the legs or arms. Damage to the nerves in the brain stem, the area of the brain that connects to the spinal cord, may affect balance. People with severe cases of multiple sclerosis may lose the ability to walk or speak clearly.

In many patients with multiple sclerosis, the symptoms often come and go — sometimes disappearing for months. However, some people have chronic symptoms that gradually get worse. People who have a close relative with multiple sclerosis are more likely to develop the disease.

Causes

Multiple sclerosis is believed to be an autoimmune disease, in which the body's immune system attacks its own tissues, in this case those of the nervous system. Many nerves fibres in the brain and spinal cord are covered by a protective coat of fatty substance called myelin. In multiple sclerosis, the misfire of autoimmune process damages myelin, leaving holes within it, a process known as demyelination.

Put simply, myelin is like the insulation on electrical wires. Damage to myelin causes interference in the communication between the brain, spinal cord and other areas of the body. The messages that travel along the nerve fibres tend to become slow or

get blocked. At first, the damage may be limited to only one nerve, but myelin covering other nerves may become damaged over time. This process is not reversible.

Doctors and researchers still don't understand why multiple sclerosis develops in some people and not others. A combination of factors, ranging from genetics to childhood infections, may play a role.

Multiple sclerosis has no definite cure. However, treatments may help treat MS attacks, manage symptoms and reduce progress of the disease.

Risk factors

Several factors may increase the risk of developing multiple sclerosis; these include:

Age

Multiple sclerosis can occur at any age, but most commonly develops in people who are aged between 20 and 40.

Gender

Women are about twice as likely as men to develop multiple sclerosis.

Family history

If one of the parents or siblings has multiple sclerosis, a person has a 1 to 3 per cent chance of developing the disease – as compared with the risk in the general population, which is just a tenth of 1 per cent.

Certain infections

A variety of viruses, such as Epstein-Barr virus and others, appear to be associated with multiple sclerosis.

Geographic regions

Multiple sclerosis is far more common in areas such as Europe, southern Canada, northern United States, New Zealand and south-eastern Australia.

If a child moves from a high-risk area to a low-risk area, or vice versa, he or she tends to acquire the risk level associated with his or her new home area. But if the move occurs after puberty, the young adult usually retains the risk level associated with his or her first home.

Other autoimmune diseases

Those who have thyroid disease, type 1 diabetes or inflammatory bowel disease may be slightly more likely to develop multiple sclerosis.

Symptoms

Symptoms of multiple sclerosis vary, depending on the location of affected nerve fibres. The symptoms may include:

- Partial or complete loss of central vision, usually in one eye, often with pain during eye movement (optic neuritis)
- Double vision or blurring of vision
- Numbness or weakness in one or more limbs
- Tingling or pain in parts of your body
- Electric-shock sensations that occur with certain head movements
- Tremor, lack of coordination or unsteady gait
- Slurred speech
- Fatigue, which may be persistent
- Dizziness
- Heat sensitivity: Small increases in body temperature can trigger or worsen multiple sclerosis symptoms.
- Stress can also worsen the symptoms

Course of the disease

There are two types of multiple sclerosis. In the most common, known as relapsing-remitting multiple sclerosis, symptoms last for days or weeks and then clear up for months or even years. However, some symptoms may eventually persist between attacks.

About 3 in 10 people with multiple sclerosis have a type known as chronic progressive multiple sclerosis, in which there is a gradual worsening of symptoms with no remission. A person with relapsing-remitting multiple sclerosis may however go on to develop a chronic progressive multiple sclerosis.

Complications

In some cases, people with multiple sclerosis may also develop:

- Muscle stiffness or spasms
- Paralysis, most typically in the legs
- Problems with bladder, bowel or sexual function
- Lapses in memory and difficulty in concentrating
- Depression
- Epilepsy

Seeing a doctor

Although you're likely to start by seeing your family doctor, he or she is likely to refer you to a neurologist (a specialist doctor trained in nervous system disorders). The doctor is likely to ask you a number of questions, such as: When did you begin experiencing symptoms? Have your symptoms been continuous or occasional? How severe are your symptoms? What, if anything, seems to improve your symptoms? What, if anything, appears to worsen your symptoms? Does anyone in your family have multiple sclerosis?

Tests and diagnosis

Multiple sclerosis can be difficult to diagnose early in the course of the disease. To diagnose multiple sclerosis, doctors will evaluate you; review your medical history and review your symptoms. S/he will also conduct a physical examination. S/he may order several tests to diagnose multiple sclerosis and rule out other conditions that may have similar signs and symptoms.

Blood tests

Analysis of your blood can help rule out some infectious or inflammatory diseases that have symptoms similar to multiple sclerosis.

Spinal tap (lumbar puncture)

In this procedure, a doctor or nurse inserts a needle into your lower back to remove a small amount of spinal fluid for laboratory analysis. Doctors test the fluid for abnormalities associated with multiple sclerosis, such as abnormal levels of white blood cells or proteins. This procedure also can help rule out viral infections and other conditions that can cause neurological symptoms similar to those of multiple sclerosis.

Magnetic resonance imaging (MRI)

An MRI uses powerful magnets and radio waves to produce detailed images of your brain, spinal cord and other areas of your body. An MRI can reveal lesions, which may appear due to myelin loss in your brain and spinal cord. However, these types of lesions also can be caused by rare conditions, such as lupus, or even common conditions



such as migraine and diabetes. The presence of these lesions isn't definitive proof that you have multiple sclerosis.

Doctors may inject a dye into a blood vessel that may help highlight "active" lesions. This helps doctors know whether your disease is in an active phase, even if no symptoms are present.

Evoked potential test

This test measures electrical signals sent by your brain in response to stimuli. An evoked potential test may use visual stimuli or electrical stimuli in which short electrical impulses are applied to your legs or arms. This test can help detect lesions or nerve damage in your optic nerves, brainstem or spinal cord even when you don't have any symptoms of nerve damage.

Treatments and drugs

Multiple sclerosis has no cure. Treatment usually focuses on strategies to treat MS attacks, manage symptoms and reduce the progress of the disease. Some people have such mild symptoms that no treatment is necessary.

Strategies to treat attacks

Corticosteroids

Corticosteroids are mainly used to reduce the inflammation that spikes during a relapse. Examples include oral prednisolone and intravenous methylprednisolone. Side effects may include mood swings, seizures, weight gain and an increased risk of infections.

Plasma exchange (plasmapheresis)

This procedure removes some blood from your body and mechanically separates your blood cells from your plasma, the liquid part of your blood. Doctors then mix your blood cells with a replacement solution and return the blood to your body.

Plasma exchange sometimes may be used to help combat severe symptoms of multiple sclerosis relapses in people who aren't responding to intravenous steroids.

Strategies to slow progress of the disease

Beta interferons

These types of drugs – such as Avonex, Betaseron, Extavia and Rebif – appear to slow the progress of multiple sclerosis, reduce the number of attacks and lessen the severity of attacks. Interferons can cause many side effects, including reactions in the injection area and liver damage. However, it's rare to have serious, permanent side effects. You will likely need blood tests to monitor your liver function and blood count.

Glatiramer acetate

This medication may reduce the number of MS attacks. Doctors believe that glatiramer acetate works by blocking your immune system's attack on myelin. You must inject this drug under your skin (subcutaneously) once daily.

Side effects are uncommon, but may include flushing, chest pain or heart palpitations after injection and reactions at the injection sites.

Fingolimod

An oral medication given once daily, this works by trapping immune cells in lymph nodes. It may reduce attacks of MS and short-term disability.

To take this drug, you'll need to have your heart rate monitored for six hours after the first dose because the first dose can slow your heartbeat (bradycardia). You'll also need to be immune to the chickenpox virus (varicella-zoster virus). Other side effects may include diarrhoea, cough and headache.

Natalizumab

This medication may reduce the number of MS attacks by interfering with the movement of potentially damaging immune cells from your bloodstream to your brain and spinal cord.

Natalizumab generally is reserved for people who see no results from or cannot tolerate other types of treatments. This medication increases the risk of progressive multifocal leukoencephalopathy (PML) – a brain infection that usually is fatal. A blood test helps detect whether you've been exposed to the JC virus, a virus that causes PML, before or while taking this medication. This virus, as

well as other risks, may cause development of PML in people taking this medication. Other side effects of natalizumab may include allergic reactions, infections or liver damage.

Mitoxantrone

This immunosuppressant medication can be harmful to the heart, and it's associated with development of blood cancers like leukaemia. Due to these risks, it's usually only used to treat active severe, advanced multiple sclerosis, based on both clinical assessment and MRI studies.

Teriflunomide

This oral medication reduces attacks and lesions in people with MS. You'll need blood tests to monitor liver function, as it may cause serious liver damage. It can also cause serious foetal damage, and it must not be taken during pregnancy. It may also cause side effects such as diarrhoea and nausea.

The medication stays in your system for months. If you have complications, additional medications must be administered in order to help your body rapidly eliminate the drug.

Strategies to treat symptoms

Physical therapy

A physical or occupational therapist can teach you stretching and strengthening exercises and show you how to use devices that can make it easier to perform daily tasks.

Dalfampridine

This oral medication may improve walking speed in some people. The major side effect is seizures.

Muscle relaxants

If you have multiple sclerosis, you may experience painful or uncontrollable muscle stiffness or spasms, particularly in your legs. Muscle relaxants such as baclofen and tizanidine may improve muscle spasticity.

Baclofen may increase weakness in the legs and cause side effects such as weight gain and excessive sweating. Tizanidine may cause drowsiness or a dry mouth.

Medications to reduce fatigue

Medications such as amantadine may help reduce fatigue due to multiple sclerosis.

Other medications

Medications also may be prescribed for depression, pain, and bladder or bowel control problems that may be associated with multiple sclerosis. A number of other medications and procedures to treat multiple sclerosis are under investigation. For example, stem cell transplantation is being studied. In a stem cell transplant, doctors inject healthy stem cells into your body to replace diseased stem cells.

Lifestyle and home remedies

These suggestions may help relieve some symptoms of multiple sclerosis:

Get plenty of rest

Fatigue is a common symptom of multiple sclerosis. Although generally it's unrelated to your activity level, resting may make you feel less tired.

Exercise

Regular exercise, such as walking, swimming, weight training and other physical activity,

may offer some benefits if you have mild to moderate multiple sclerosis. Benefits of physical activity include improved strength, muscle tone, balance and coordination, bladder and bowel control, and less fatigue and depression.

Cool down

Multiple sclerosis symptoms often worsen when the body temperature increases. Keep cool by running cool water on your wrists, staying in

air-conditioned areas, swimming in cool pools and drinking cold beverages.

Eat a balanced diet

Eating a healthy, balanced diet can help you maintain a healthy weight, keep a strong immune system and maintain bone health.

Relieve stress

As stress may trigger or worsen multiple sclerosis symptoms, try to find ways to relax. Activities such as yoga, massage, meditation or deep breathing – or just listening to music – might help. Stay connected to friends and family. Continue to pursue hobbies that you enjoy and are able to do. Maintain normal daily activities as best you can.

Continued from page 6 (Doing chemistry with computers)

molecules such as enzymes. Warshel arrived at Harvard in 1972 to collaborate with Karplus and they decided that it is not necessary to simulate the entire chemical molecule with great accuracy. Although many biological molecules are big, their active sites – the bits which actually perform the exciting reactions – are small regions of the molecule. So the two researchers came up with

A unique achievement of the work of Karplus, Levitt and Warshel was to use a hybrid approach that used quantum mechanics to model the interesting parts of a molecule, but simulated the rest with faster, more rough-and-ready Newtonian methods. Quantum mechanics could explain the making and breaking of chemical bonds, while classical Newtonian mechanics captured the physical movement of proteins. Previously, chemists had to choose to use one or the other. The strength of classical physics was that calculations were simple and could be used to model really large molecules, but it offered no way to simulate chemical reactions. For that purpose, chemists had to fall back on quantum physics. But such calculations required enormous computing power and could therefore only be carried out for small molecules. The work of the trio combined the strengths of both – they took the best from both worlds and devised methods that use both classical and quantum physics. Their novel approach combined both classical and quantum physics, and now enables us to understand how very large molecules react.

Computational chemistry has today become an inseparable part of many

industrial processes such as design of new materials, the design of solar cells, or development of catalysts used in cars. Computer programs can be used to mimic the process of photosynthesis by which green

plants absorb sunlight and produce oxygen. Ultimately, the ability to computerise such complex chemical processes might make it possible to simulate a complete living organism at the molecular level.

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Plastic raw material found in space

Propylene, also known as propene or methylethylene, is an unsaturated organic compound having the chemical formula C_3H_6 . It has one double bond, and is the second simplest member of the alkene class of hydrocarbons. Propylene is one of the major building blocks of the petrochemical industry. This chemical is all around us in everyday life, strung together in long chains to form a plastic called polypropylene. It is a key component of countless end use products. Examples include automobile headlights, taillights, disk brake pads and bumpers, CDs; clear film food wrap, eyeglasses, flexible foams used in bedding and furniture, rigid foam insulation, impact-resistant and bullet-proof windows, moulded plastic goods such as buckets, food containers, kitchen utensils and wastebaskets, and laminates, to name a few.

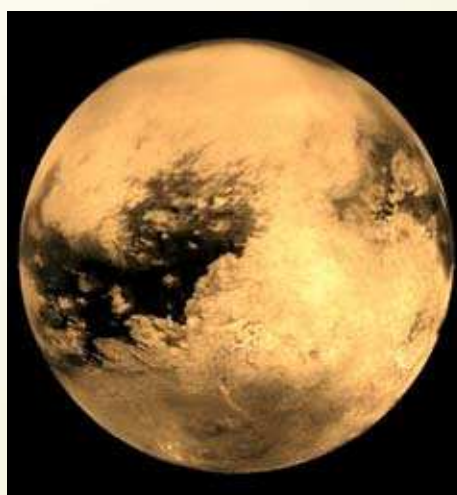
On Earth, propylene is produced from fossil fuels – petroleum, natural gas, and, to a much lesser extent, coal. Recently NASA announced that the spacecraft *Cassini* has detected the presence of propylene in outer space – in the lower atmosphere of Saturn's largest moon Titan, which is among the few bodies in the solar system with a significant atmosphere made up of hydrocarbons. It is the first time propylene has been detected on another world although the gas is only present in a few parts per billion in Titan's atmosphere. The discovery was made by *Cassini*'s infrared spectrometer (*Astrophysical Journal Letters*, 10 October 2013 | doi: 10.1088/2041-8205/776/1/L14).

According to Conor Nixon, a planetary scientist at NASA's Goddard Space Flight Center, and lead author of the paper, "This chemical is all around us in everyday life, strung together in long chains to form a plastic called polypropylene."

The atmosphere of Titan is largely composed of nitrogen; minor components lead to the formation of methane and ethane clouds and nitrogen-rich organic smog. The climate – including wind and rain – creates surface features similar to those of Earth, such

as dunes, rivers, lakes and seas (probably of liquid methane and ethane), and deltas, and is dominated by seasonal weather patterns as on Earth.

Titan has been known to be among the few bodies in the solar system with a significant atmosphere made up of hydrocarbons. It is dominated by methane, which after nitrogen is the most common



Titan, Saturn's largest moon. Dark areas are hydrocarbon lakes.

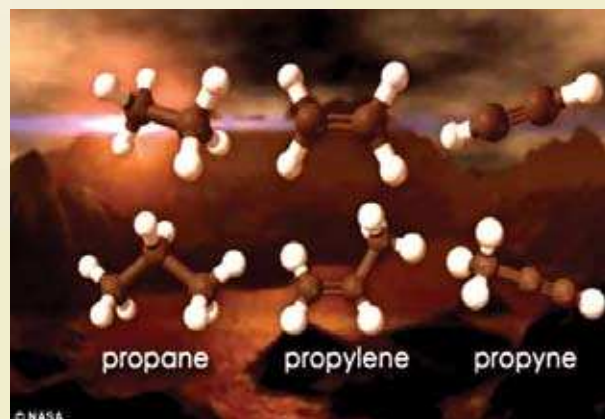
component of its atmosphere. Ultraviolet radiation from the Sun breaks apart the methane, allowing the fragments to join up and form even bigger molecules. Other common species seen on Titan as a result are propane, which on Earth is used in portable cooking stoves, and ethane, which is the raw material for another ubiquitous plastic – polyethylene.

NASA's *Voyager* spacecraft had previously identified many of the gases in Titan's brownish atmosphere as hydrocarbons, the chemicals that primarily make up petroleum and other fossil fuels on Earth. From the three-carbon family, the spacecraft found propane, the heaviest member, and propyne, one of the lightest members. But the middle chemicals, one of which is propylene, were

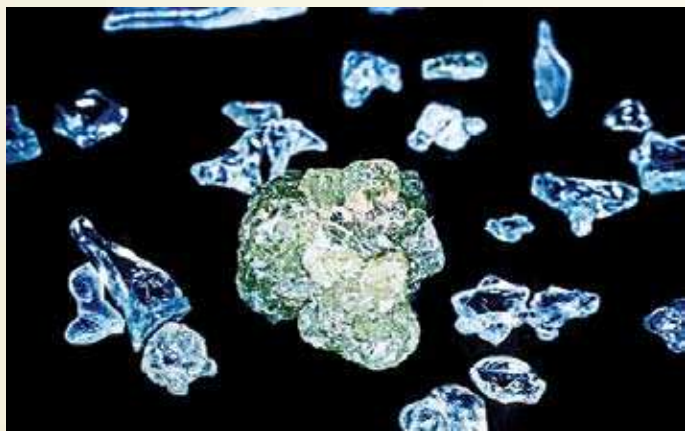
missing. The recent discovery fills the gap. The find's scientific significance has more to do with how chemistry works on Titan, which many scientists regard as an analogue to an age on ancient Earth before oxygen became a significant ingredient of the atmosphere.

It may be raining diamonds on Jupiter and Saturn

It sounds like science fiction, but some planetary scientists believe there may be several million tons of diamonds stored in Saturn and Jupiter. Carbon in its dazzling crystal form may be abundant on the solar system's two largest planets. Researchers have long wondered whether the high pressures inside the giant planets could turn carbon into diamond. Now Mona Delitsky of California Specialty Engineering in Pasadena, California and Kevin Baines of the University of Wisconsin-Madison, claim it is possible. Speaking at the 45th meeting of the Division for Planetary Sciences of American Astronomical Society in Denver, Colorado, they presented the probable scenario that could lead to the formation of diamond on the two planets (*Nature*, 9 October 2013 | doi:10.1038/nature.2013.13925). The researchers arrived at their conclusion after analysing the latest temperature and pressure predictions for the two planets' interiors, as well as new data on how carbon behaves in different conditions. They also compared recent studies that experimentally worked



Hydrocarbon in Titan's atmosphere



It may be raining diamonds on Saturn and Jupiter.

out the temperatures and pressures at which carbon takes on different forms, such as solid diamond, and others that modelled the pressure and temperature at different depths within the giant planets.

In the scenario contemplated by Delitsky and Baines, lightning breaks up molecules of methane in the upper atmospheres of Saturn and Jupiter, liberating carbon atoms. These atoms then stick onto each other, forming larger particles of carbon soot. Such soot has been observed by the *Cassini* spacecraft in dark storm clouds on Saturn. As the soot particles slowly float down through ever-denser layers of gaseous and liquid hydrogen towards the planets' rocky cores, they experience ever greater pressures and temperatures. The soot is compressed into graphite, and then into solid diamond crystals. According to the researchers, inside Saturn, the conditions are right for diamond 'hail' to form, beginning at a depth of about 6,000 kilometres into the atmosphere and extending for another 30,000 km below that. They estimate that Saturn may harbour about 10 million tonnes of diamond produced this way, with most of it made up of crystals no bigger than a millimetre and perhaps some chunks as large as 10 centimetres across. But further down, as the temperature rises to about 8,000°C, the diamond melts, forming 'liquid diamond' raindrops. According to the researchers, at the greatest depths of Jupiter's atmosphere, the conditions are so extreme that the gems may actually form an ocean of liquid diamond.

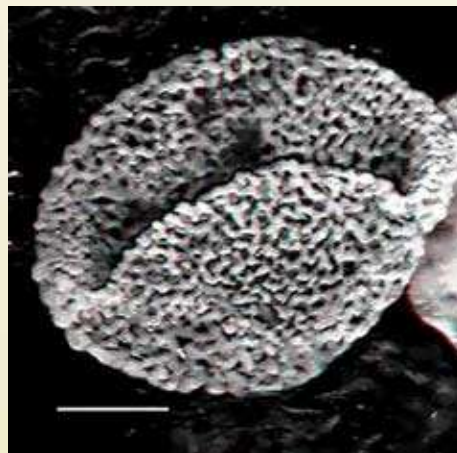
According to Baines and Delitsky, chunks of diamonds may be floating in hydrogen and helium fluid deep in the atmospheres of Saturn and Jupiter. What's more, at even lower depths, the extreme pressure and temperature can melt the

precious gem, literally making it rain liquid diamond. Scientists have known that stable diamonds may exist in the relatively chilly cores of Neptune and Uranus, but until now, Jupiter and Saturn were thought to be too hot to allow for the formation of solid, stable diamond. Although it is still a mysterious process, scientists think that, on Earth, diamonds

form naturally when carbon is buried about 160 kilometres below the surface, where the temperature is of the order of about 1,100°C and a pressure of almost 50,000 atmospheres.

Flowering plants appeared 100 million years earlier than believed

The flowering plants or angiosperms are the most diverse group of land plants. The oldest known fossils from flowering plants are pollen grains. Pollen grains are small, robust and numerous, which makes them easier to find in the fossil record than comparably large and fragile leaves and flowers. Flowering plants are known to have evolved from extinct plants related to non-flowering plants such



Flower-like pollen from the Triassic Period. (Credit: UZH)

as conifers, ginkgos, cycads, and seed ferns.

Flowering plants, or angiosperms, became the dominant plants about 90 million years ago. However, the exact time when these plants originated remains hotly

debated. Till recently the oldest known fossils of flowering plants were about 140 million years old and flowering plants were believed to have appeared around that time. A new study documents flowering plant-like pollen that is 100 million years older. Scientists have unearthed ancient pollen grains with microscopic features typically seen in flowering plants. After analysing the structure of these grains, the researchers suggest that the associated plants were pollinated by insects – most likely beetles, as bees did not evolve until about 100 million years later.

The well-preserved fossils, discovered in two core samples drilled in northern Switzerland, are about 245 million years old, meaning that flowering plants may have originated between 252 to 247 million years ago or even earlier during the Triassic Period (*Frontiers in Plant Science*, 1 October 2013 doi:10.3389/fpls.2013.00344). Peter Hochuli and Susanne Feist-Burkhardt from Paleontological Institute and Museum, University of Zürich, studied two drilling cores from northern Switzerland, and found pollen grains that resemble fossil pollen from the earliest known flowering plants. In other words, this means that flowering plants may have been around when the earliest known dinosaurs were around.

Six different types of pollen were found in the ancient samples, revealing that 245 million years ago flowering plants may have been considerably diverse. The researchers have seen these pollen grains in both Switzerland and the Barents Sea, north of Scandinavia. However, around 245 million years ago, both areas were located in the subtropics, and the region that is now Switzerland was much drier than the Barents Sea region, suggesting the flowering plants spanned a broad range of environments.

According to palaeontologists, the fossil record of flowering plants is continuous, dating back 140 million years. Until now, the fossil record of flowering plants suggested they dominated the planet rather quickly after their earliest appearance. However, the sudden appearance has bothered scientists ever since Darwin, who called the origin of flowering plants an 'abominable mystery'. The recently discovered fossils extend the span of time flowering plants have been around and this increased span of time might help explain how flowering plants spread, diversified and prevailed on land.

World's first malaria vaccine may be ready by 2015

Malaria is an infectious disease of tropical countries, spread by mosquitoes. It is manifested by fever along with chills and rigors. Unless it is diagnosed and treated promptly, it can be fatal. A single mosquito bite may be enough to cause the infection. Worldwide, more than 200 million people a year get infected, and at least 660,000 – mostly children – get killed.

Despite some reduction in the number of deaths from malaria, the disease still remains a major threat in India. An estimated 1.2 million fresh cases of the disease are reported in India each year. About 95 per cent of the country's population resides in malaria endemic areas. According to the



Plasmodium parasite that causes malaria.

World Malaria Report 2011, over 70 per cent of the country's 1.2 billion population faces the risk of malaria infection, with an estimated 310 million people – one-third of the total – facing the "highest risk".

Malaria is caused by a parasite – the plasmodium – which is more complex than many viruses or bacteria. The malaria parasite is very complex and it is able to adapt and develop resistance to drugs. So even when a remedy is found, it stops working after a few years. Since the malaria parasite develops in the human liver, the new vaccine called RTS,S has been engineered to attach to another vaccine for hepatitis B – which operates in the same region of the body. This technique may be improving the vaccine's efficacy.

The RTS,S vaccine was developed in the early 1980s by a UK-based pharmaceutical firm GlaxoSmithKline (GSK) and the US-based Walter Reed Army

Institute. According to the researchers who developed the vaccine, it has been difficult to develop a vaccine against malaria because of the complexity of malaria infection and it was almost impossible until now to understand what provokes immunity responses to malaria.

The first tests, on US adults in the early 1990s, proved the concept worked, setting in motion a series of trials that have shown how effective the vaccine could be across Africa, where malaria is most prevalent. Now encouraging results from the longest and largest clinical trial of a new malaria vaccine could see the world's first anti-malaria vaccine approved by 2015. This is the first time that a malaria vaccine has undergone such a large scale and advanced trial. The Phase III trials started in 2009, involving 15,000 children across seven countries in sub-Saharan Africa – Gabon, Mozambique, Tanzania, Ghana, Kenya, Malawi, and Burkina Faso. Phase III trials are the final stage of testing before a vaccine – or any new drug – can be submitted for approval. Once approved, the RTS,S vaccine could be ready for use as early as 2015.

During Phase III trials, the vaccine was tested in 15,000 children by GSK in collaboration with PATH Malaria Vaccine Initiative, backed by grants from the Bill and Melinda Gates Foundation. Half were babies aged 6 to 12 weeks and the other half toddlers aged 5 to 17 months. Half in each group received the vaccine and half a placebo, and all continued where possible with other precautions to prevent malaria such as sleeping under bed nets. The latest data show that eighteen months into the trial, the vaccine continued to work best in the older

Obituary



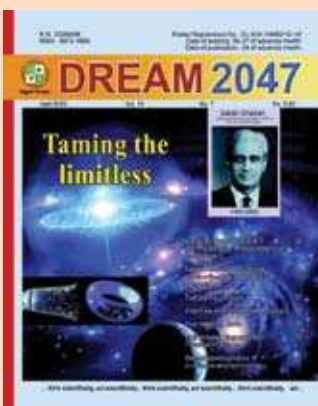
We are extremely sorry to inform that Dr. Hari Krishna Devsare, former Fellow of Vigyan Prasara died on 14 November 2013. A well-known name in Hindi Children's literature, Dr. Devsare worked in Vigyan Prasara for five years, and he was closely associated with the publication of Dream 2047. A write-up on life and work of Dr. Devsare will be published in the next issue of Dream 2047.

age group, providing the strongest evidence yet that the shot nearly halves the number of cases of malaria in babies aged five to 17 months, and paving the way for its release. The trials so far have shown that the RTS,S vaccine could reduce malaria infections in children by more than 50 per cent. The researchers say a 50 per cent success rate in the fight against malaria is significant. ■

Articles
invited

Dream 2047

Vigyan Prasara invites original popular science articles for publication in its monthly science magazine *Dream 2047*. At present the magazine has 50,000 subscribers. The article may be limited to 3,000 words and can be written in English or Hindi. Regular columns on i) Health ii) Recent developments in science and technology are also welcome. Honorarium, as per Vigyan Prasara norm, is paid to the author(s) if the article is accepted for publication. For details please log-on to www.vigyanprasara.gov.in or e-mail to dream@vigyanprasara.gov.in



'Cosmos from my Terrace' – New Initiative of Vigyan Prasar

Astronomy is a fascinating subject that attracts not only students but also laymen and amateurs. Curiosity to understand the subject is very common in all age groups. Historically, astronomy is the oldest subject to which many philosophers, mathematicians and astrologers have contributed. The invention of the telescope by Hans Lippershey and later its use by Galileo to observe the sky changed the entire scenario of observational astronomy.

Over the last 18 years, Vigyan Prasar has procured many astronomical instruments and gadgets including telescopes and other back-end instruments. These instruments have been



Students & Teachers of K.R. Mangalam World School, Gurgaon with 1100 CGE Celestron Telescope (automated)

Vigyan Prasar advertised the availability of these facilities and received a large number of applications. Based on previous experience

and location in the Delhi and NCR, four schools were selected. A training programme was also organised for selected teachers and students from the four schools in September.

The training programme started at KR Mangalam World School, Gurgaon, wherein, Dr (Ms) Neetii C. Kaoshik, Principal and Dr T. V. Venkateswaran, Scientist F, Vigyan Prasar were



Students and teachers of Kerala Education Society Senior Secondary School, R.K. Puram with 203-mm Newtonian reflector telescope.

extensively used for observing planets, star clusters, and also cosmic events like eclipses, transits of inner planets, etc. Apart from making observations, these are also used to generate scientific data like photometric observations of stars and atmospheric extinction values in and around Delhi and NCR.

Vigyan Prasar has now decided to make the best use of these facilities by lending these to various schools/ colleges/amateur groups in and around New Delhi for six months. The first observation slot is from 15 September 2013 to 15 March 2014. The facility is being provided to generate interest in astronomy among locals and students from schools in the vicinity.

present. A lecture on 'History of Indian Astronomy' was delivered by Dr. T. V. Venkateswaran and Dr. Arvind C. Ranade,

Scientist, VP briefed the participants on 'Basics of Telescope' and 'Comet ISON'.

In the programme, maximum emphasis and time was given to hands-on experience, which were demonstrated by Mr R K Yadav (ARIES, Nainital), Mr Mani (AAAD, New Delhi), Mr Sanjiv Sharma (Kalpana Chawla Memorial Planetarium, Kurukshetra), and Mr Vipin Singh Rawat (Vigyan Prasar). Students and teachers also had fun-filled sessions of night sky observation on the terrace of school using telescopes and back-end instruments.

The workshop culminated with the distribution of certificates to participants



Students and teachers of Bal Bharti Public School, Pitam Pura with 120-mm Newtonian reflector telescope.

by Chief Guest, Ms Neetii C Kaoshik and Guest of Honour, Dr R Gopichandran, Director, VP.

Telescopes and other accessories were handed over to the selected schools on 10 September. The programme was coordinated by Ms Puneeta Malhotra, middle school coordinator of K R Mangalam School, Gurgaon and Ms Chavi of Vigyan Prasar, Noida. The landing of the telescopes would be rescheduled from 15th March 2014 to 15th September 2014 for newly selected schools or institutions. This cycle will be repeated again till the end.



Students and teachers of Delhi Public School, Ghaziabad with 102-mm Celestron Nexstar automated Star Locating Telescope (SLT).

(Report by : Arvind C Ranade) ■