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OUR MOM

P. Radhakrishnan, Former Deputy Director, LPSC, VSSC

On the morning of September 24, 2014, a jubilant Prime Minister Narendra Modi said, *"Mom ko Mangal mila ; Mangal ko Mom mila"* (Mom got Mars ; Mars got Mom). MOM stands for Mars Orbiter Mission, the Indian Mars mission that achieved a substantial part of its goal in that September morning. The Prime Minister richly complimented the ISRO scientists and engineers of ISRO for achieving "the near-impossible". Sitting in the Mission Control Centre, Bangalore, he witnessed the exciting sequence of events that culminated in the Indian spacecraft, *Mangalyaan*, smoothly settling into an orbit around Mars. Most remarkably, MOM was transformed from an idea to reality in less than two years on a shoe-string budget of Rs. 450 crores. There have been over 50 Mars missions undertaken by the former Soviet Union and the USA from the 1960s, and much later by Europe, Japan and China. The overall success rate is a paltry 35 % ! Our creditable achievement can claim the distinction that we are the first to succeed in the maiden attempt.

Mangalyaan had a reception committee waiting for its arrival. There was the MAVEN (USA) that reached there only three days earlier. Besides, there were the Mars Reconnaissance Orbiter and Mars Odyssey (both of USA) and Mars Express (Europe). While these were orbiting around Mars, on the surface of the planet, there were two functioning US rovers, Opportunity and Curiosity. By the way, in the mid-1970s, Viking -1 and 2 spacecraft of US had landed on Mars. Clearly, mankind has a special interest in our *earth-like* next-door neighbor, Mars, also known as the 'Red Planet', for its

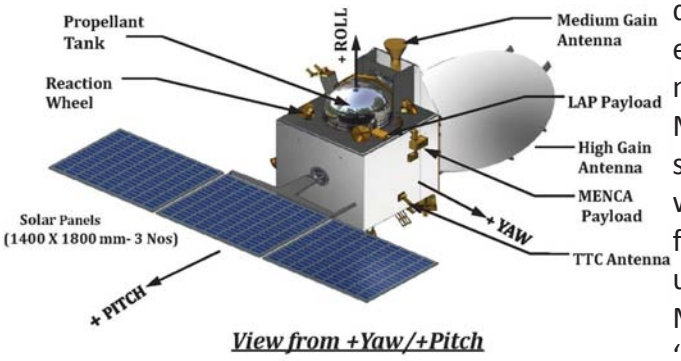
red tint caused by Iron Oxide. For the ancient Greeks, Mars was their Warrior God.

Mars is nearly 52 % farther away from the sun than us and, therefore, colder than us. The temperature is as low as -50p C even at noon during the peak of summer. Gravity on Mars is 38 % that on the earth. It has an atmosphere with 95 % Carbon Dioxide exerts a pressure about 0.7 % of earth's atmospheric pressure. It has no magnetic field though one may have existed in the long past. The thin atmosphere and absence of magnetic field result in the continuous bombardment of the Martian surface by the 'solar wind' composed of high energy protons and electrons coming from the sun. On the earth, our atmosphere and magnetic field have been protecting life from the lethal solar wind capable of destroying biological molecules.

Should we ever wish to set up a human colony on Mars, the first thing in its favor is its rocky surface like the earth. Secondly, it is the nearest planet reachable in months with the currently available breed of rockets. Conceivably, Mars can be rendered habitable by *terraforming or* "earth-shaping". This is a process, if theoretical, of "planet engineering", which aims at modifying the atmosphere, temperature, surface topography or ecology of a planet or moon for it to resemble the biosphere of the earth, fit for earth-like life. We cannot send a probe or travel to Mars (or any other planet) at any time we choose. Our foremost consideration in a space journey, particularly a long one to another planet, is to accomplish with minimum energy (fuel) consumption. Such a minimum energy trajectory (path) is afforded by what is known as the *Hohmann Transfer Ellipse*. Since earth and the planets are all in motion around the sun, we must start our journey, say, to Mars, at an appropriate time so that our spacecraft and Mars will simultaneously be at a certain position in future facilitating a rendezvous. The opportune time for journey to Mars occurs only once in about 26 months when earth, sun and Mars are in certain relative positions. (In more precise terms, the geometrical pattern is such that Mars, in its orbit, is ahead of earth by about 44p with respect to the sun-earth line). India did not want to miss the opportunity ('*launch window*') that lasted for about 20 days in November 2013. This explains the timing of MOM.

PSLV (Polar Satellite Launch Vehicle), our workhorse, took off from SDSC (Satish Dhawan Space Centre) at Sriharikota at 02:38 PM on November 5, 2013. Within 42 minutes, *Mangalyaan* was injected into elliptical orbit around earth with perigee of 264 km and apogee of 23900 km. Later the LAM (Liquid Apogee Motor) – a liquid rocket – was fired at the perigee on five occasions during November 2013, eventually raising the orbit of *Mangalyaan* to about 193000 km. The sixth and final push was given by LAM on December 1, 2013 that broke *Mangalyaan* free from the clutches of earth's gravity, ending the first phase of the mission. During the second phase lasting for about 300 days, the spacecraft was travelling under the sun's gravity, and its trajectory was corrected a few times by firing small liquid rocket thrusters. In the third phase of the mission, as *Mangalyaan* approached Mars, its velocity had to be reduced to less than the escape velocity of Mars in order that it is captured by Mars into an orbit. If the velocity (speed and direction) is not correct, *Mangalyaan* would miss the goal and fly-by Mars to drift away in space. This operation needed LAM to be fired after 300 days of hibernation ! On September 22, 2014, LAM was test-fired for four seconds to confirm that it works correctly after the long period of inactivity. This test successfully carried out, the stage was set for orbit insertion. Thus on the morning of September 24, 2014, *Mangalyaan* did a turn-about and fired LAM so that it produced a thrust in a direction opposite (retro) to the motion for 24 minutes. The resulting braking effect would appropriately reduce the velocity for settling into an orbit. The necessary commands had already been uploaded on board *Mangalyaan* in advance along with instructions to release them at the appointed times. Soon after LAM was fired, *Mangalyaan* went behind Mars, disappearing from our view and resulting in a *'communication black-out'*. No radio communication was possible until it came out from behind Mars many minutes later. Finally, the message that orbit insertion has taken place reached us 12

minutes later because of the distance (about 22 crore km) between *Mangalyaan* and earth at that time. Now in its 420 km x 77,000 km orbit, *Mangalyaan* goes round Mars once in 73 hours. 'Mars Color Camera', the first payload to be switched on, has started sending pictures of Mars. The other four scientific payloads, namely, Methane Sensor, Thermal Infrared Imaging Spectrometer, Lyman Alpha Photometer and Exospheric Neutral Composition Analyzer will be turned on in due course.



View from +Yaw/+Pitch

ISRO has proved its mastery in designing, planning and executing an interplanetary mission. With the successful MOM behind us, other space agencies of the world will readily come forward to collaborate with us in future space projects. MOM is essentially a 'Technology Demonstrator' rather than a scientific mission. Data obtained from the scientific payloads in the days to come would only be a bonus !

Celebrating 100 Years of X - Ray Crystallography

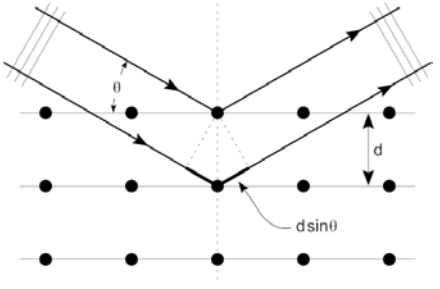
Prof. V. Unnikrishnan Nayar
School of Physics, IISER, Thiruvananthapuram

Crystallography is the science that deals with the arrangement of atoms or molecules in a solid. Before the advent of X-ray crystallography the study of crystal was based on their geometry. This involves determining the angles of crystal faces relative to reference axes and establishing the symmetry of the crystals. The basic unit is considered as a unit cell. The crystal structure can then be considered as an infinitely repeating array of these unit cells.

The discovery of X-rays in 1895 by Roentgen changed the level of crystallography. Roentgen took the photograph of the hand of his wife. This has led to the use of X-rays for structure determination in solids. X-rays can pass through various solids and they undergo diffraction at the atoms in molecules and solids. Roentgen got first Nobel prize for Physics


Roentgen

in 1901 for his discovery. There have been different theories for X-rays, but von Laue determined that X-rays undergo diffraction as light waves when these pass through crystals. He got the Nobel prize in 1914. Many discoveries in X-ray crystallography followed Laue's work. William Henry Bragg and his son William Lawrence Bragg constructed an X-ray spectrometer and carried out studies in X-ray crystallography. Lawrence Bragg formulated Bragg's law of X-ray diffraction for studies of the structure of crystals, $2d\sin\theta=n\lambda$. Here *d* is the spacing between diffracting planes, θ is the incident angle, *n* is any integer, and λ is the wavelength of the beam. Both Braggs shared Nobel prize for

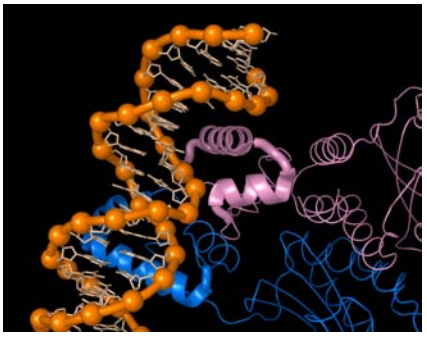


Bragg diffraction pattern

these studies in X-ray crystallography in 1915. By measuring the angles and intensities of these diffracted beams, a crystallographer can produce a three-dimensional picture of the density of electrons within the crystal. From this electron density, the mean

positions of the atoms in the crystal can be determined, as well as their chemical bonds, their disorder and various other information. The earliest structures were generally simple and marked by one-dimensional symmetry. However, as computational and experimental methods improved over the next decades, it became feasible to deduce reliable atomic positions for more complicated two and three-dimensional arrangements of atoms in the unit-cell. In 1914, the distribution of electrons in the table-salt structure showed that crystals are not necessarily composed of covalently bonded molecules, and proved the existence of ionic compounds. This was the first structure to be identified. The structure of diamond was determined in the same year. X-ray crystallography was followed by the use of electrons and neutrons for diffraction studies of materials. They also gave complementary information on structure of materials. Nearly 28 Nobel prizes in Physics and Chemistry were given for crystallography studies. Considering the importance of crystallography, United Nations decided to observe 2014 as the Year of Crystallography.

Crystals assume different geometrical shapes depending on the ordering of their atomic structure and physical and chemical conditions under which they grow. They can be classified into seven crystal lattice systems on the basis of the symmetry of the atomic arrangement i.e., Cubic, Tetragonal, Orthorhombic, Rhombohedral,Hexagonal, Monoclinic and Triclinic. Goniometers are used in X-ray crystallography to measure angles between crystal faces. They rotate the samples enabling the determination of the crystal structure correctly. In the present experimental arrangement techniques have been employed to get high resolution. Advent of computers helps in the determination of crystal structures. Various softwares are now available to identify the structure of molecules and crystals from X-ray diffraction spectra.



An important application of X-ray diffraction is in Biology to study the molecular structure of macromolecules, particularly protein and nucleic acids such as DNA and RNA. Several researchers have carried out studies on the structure of biological molecules including G. N. Ramachandran of Madras University. Ramachandran and Gopinath Kartha were the first to suggest a triple helical structure for collagen. But there was a delay in the publication of their paper. In the meantime the paper by James Watson and Francis Crick was published proposing double helix structure for DNA (1953). They got the Nobel prize for this study. This led Ramachandran to an intense study of the core issue in the structure, the minimum possible distance between two non-bonded atoms. This investigation eventually resulted in the celebrated Ramachandran map, proposed in 1963 by Ramachandran, Ramakrishnan and Sasisekharan.

James Watson and Francis Crick

The map sets the limits imposed on polypeptide chain conformation by the need for non-bonded atoms to keep out of each other's way. Today it provides the simplest complete description of protein conformation. It is also the most important tool for the validation of protein structure and, in a way, has immortalized Ramachandran.

G. N. Ramachandran

More studies are continuing in crystallography in different laboratories across the world. Even in 2012 Nobel prize in chemistry has been awarded for studies in G-protein-coupled structures.

Malabar Botanical Garden - A paradise for plant lovers

Dr. R. Prakashkumar, Director, Malabar Botanical Garden,
Guruvayurappan College P.O., Kozhikode.

The serene beauty of nature has always been a bounty for relief and solace for the disturbed mind from the hectic competitive modern life. The Malabar Botanical Garden situates in the suburban area adjacent to the busy metro life of Kozhikode city is a green land of soothing solitude sprawling in 45 acre area of lush green vegetation with immense diversity will be a pleasant experience for the lovers of nature and the students of biodiversity studies, a boon for future generations, conserved, perpetuated and well maintained.

The Malabar Botanical Garden was established in 1996 by the Malabar Botanical Garden Society under the Culture Department of the Government of Kerala with an objective of understanding of the biodiversity and its conservation in the erstwhile Malabar region of Kerala, especially of the Western Ghats region of this area. 15 acre area of the garden is wetland which forms a transient shallow lake during monsoon attracting numerous local and migrating birds like Ibis, Asian Openbill Stork,etc. Presently Malabar Botanical Garden is a grant in aid institution of the Kerala State Council for Science,

Technology & Environment.

Malabar Botanical Garden is a member of BGCI (Botanical Garden Conservation International) which is an International union for conservation of plants. Malabar Botanical Garden is a Research Centre in Botany of the Calicut University and several students have already started their research work for their Ph.D. Degree of the Calicut University, mainly on biodiversity (Taxonomy) studies, Conservation strategies and Molecular Systematics.

Aquagene and Sarovar

Not many Botanicals Gardens in India and elsewhere undertake the conservation of aquatic plants probably owing to the difficulties in maintenance since these plants are easily prone to severe pestilence by aquatic snails and also due to several other factors.

Considering this rarity, the Malabar Botanical Garden has initiated the construction of aquatic wetland plants in the original wetland area of the Garden. Generally aquatic plants occur in three forms: free-floating, submerged and emergent. Almost all wetland/aquatic plants of Kerala including these under RET category like *Limnopoa meeboldii*,

Nymphoides krishnakesara etc., are conserved here. More than 400 species of wetland plants are maintained in the conservatory of aquatic plants called 'Aquagene' in large pots filled with marsh land soil. All the 14 species of water lilies reported from India are well demonstrated here. The MoEF (Government of India) has recognized Malabar Botanical Garden as a LEAD Garden of India

for conservation of aquatic/ wetland plants of the country.

In addition to the display of aquatic plants in small scale (few live specimens of each species in cement pots in the Aquagene), the aquatic plants are also cultivated

envisaged in the 15 acre land of the Garden. A master plan is prepared and approved by MoEF for Aquatic Bio park with a circular island encircled by a ring-like pond with diverse aquatic plants in the 15-acre wetland area of the garden which when fully developed will be the foremost aquatic bio park of our country with the largest live collection of aquatic plants.

A Treasure of Medicinal Plants

The State Medicinal Plants Board (SMPB) has recognized Malabar Botanical Garden as the centre for the Medicinal Plant Demonstration Garden for Kozhikode District. The

Demonstration Garden has already developed with more than 300 live medicinal plants in the exhibition of 'Vaidyamadom' and 50 species of medicinal trees in the 'Sanjeevani'. Almost all plants used in the indigenous systems of medicine, such as Ayurveda, Sidha, Unani and traditional knowledge, etc. are maintained in the medicinal plant section. All medicinal plant groups such as Dasamoolam, Nalpamaram, Triphala, Trigadu and Panchavalka are exhibited here, explaining their name, families and medicinal uses. In the 'Sanjeevani' the medicinal trees are provided with platform at the base and large

boards explaining the uses of such plants. In addition, the NMPB (National Medicinal Plants Board, AYUSH) has selected Malabar Botanical Garden as a Centre for 'Herbal Garden Project' for the conservation and propagation of RET medicinal plants. Five RET medicinal plants viz., *Acorus calamus* (Sweet Flag), *Celastrus paniculatus* (Jyothirmathi), *Symplocos cochinchinensis* (Paachothi), *Baliospermum montanum* (Nagadandhi) and *Pseudarthria viscida* (Moovila) are propagated here each in half area for distribution among the farmers in future in order to break the endangered category through propagation and dispersal.

Star Forest and Plants of Mythology

According to Hindu Ephemeris, each birth star has a specific tree and those who nurture these trees will prosper in their life. So, for 27 birth stars, and 27 trees are attributed and such trees with the star names are demonstrated in Malabar Botanical Garden. For believers, it will be a pleasure to watch the specific tree species belonging to their respective birth stars in such a way the Garden

evokes interest among people for the conservation of plants in all possible ways.

In addition, the plants of epics such as the 'Simsipa tree' (*Amhersia nobilis*- Csalpiniaceae) under which the Sita devi of Ramayana is believed to be sit in Lanka in the Ashoka forest. Asoka (*Saraca asoca*) is another important tree mentioned in Ramayana growing aplenty in the garden. When Rama and Lakshmana went to the forest they were wearing 'maravuri' the soft bark of a tree- *Antiaris* sp. This tree is growing well in the garden, 'Rudraksha' (*Eleocarpus* sp.) is another tree, the tuberculated hard seeds of which are considered to be sacred and a chain of this is usually worn by the 'poojaris' and saints.

Apushpi- The Warehouse of primitive plants

The Malabar Botanical Garden is unique in the conservation of primitive nonflowering plants such as bryophytes and pteridophytes. This is the only conservatory of bryophytes which are usually

considered less than three categories; liverworts, mosses and hornworts. These are small delicate plants susceptible to desiccation and require high humidity for their existence. They are commonly called 'amphibians of the plant world' owing to this hydrophilic nature. Most of the bryophytes of Kerala are collected and conserved at the Malabar Botanical Garden.

Pteridophytes are the most primitive vascular plants originated some 350 million years ago with primitive vasculature and propagate through spores instead of seeds. Kerala is rich in pteridophyte diversity and most of pteridophytes of Kerala are well exhibited in the Apushpi of Malabar Botanical Garden.

Janakia

This is an excellent collection of plants of RET category in the Kerala region. Over 60 species of RET plants including aquatic and medicinal plants listed in the RET category by IUCN are exhibited live in this section. The IUCN category of each plant is given with other details. The endemic plant of Kerala *Bentickia coddappana* which is found only in the Sabarimala and Agasthiamala region of Kerala is well maintained here. Rare plants like *Coscinium fenestratum* (maramanjal- critically endangered) and *Ixora polyantha* (Kolinji- rare), etc. are the attraction

of this collection. This section is named after Dr. E.K. Janaki Ammal, a pioneer Botanist of Kerala.

Orchids

Over 50 wild orchids of Kerala, especially from the Western Ghats region are conserved in the Orchidarium of Malabar Botanical Garden. In addition, many hybrids and exotic orchids such as *Dendrobium* spp., *Aranda*, *Archnis, Paphiopedillum, Phelenopsis*, etc. are conserved here. The giant *Dendrobium* commonly called 'Anjooran' is a great attraction with 2m long branched inflorescence in Malabar Botanical Garden.

Bamboos and Reeds

A section of the garden is marked for the conservation of bamboos and reeds. Over 30 species of Bamboos from Kerala and North Eastern area are maintained here. This includes the local bamboos (*Bambusa* sp.), Yellow bamboo (*Bambusa striata*), walking bamboos (*Melocana sp*.) and 'Lathimula' (*Oxytenanthera sp.)*

Panathottam-The Palm Grove

Over 50 species of palms (Araceae) are conserved here which include the Rattan (*Calamus* sp.), Triangle palm (*Dypsis*), Umbrella palm (*Corypha*), Champagne palm, etc.

Climber pagoda

Over 40 species of climbing plants including woody climbers of Kerala are well maintained in a pagoda style at Malabar Botanical Garden. This is a unique collection of climbing plants. The visitors have a unique opportunity to see almost all the climbing plants of Kerala together.

Inflorescence Garden

Plants with various forms of inflorescences such as raceme, corymbs, thyrsus, head, etc. are exhibited here for educating the school children.

Systematic Garden

This is an upcoming project for the sake of inculcating interest in Plant Taxonomy in the younger student generation. Taxonomy is generally considered as a narrow subject owing to its cumbersome technicalities and vastness. Hence the live plants are displayed according to their taxonomic

position based on Benthem and Hooker's (1862-1893) Classification which is generally adopted by Indian angiosperm taxonomists. Each family is illustrated with an example species, the Division, Order and family characters are displayed against each section. The plants are kept under two general categories, in two separate green houses such as Dicots and Monocots.

The Dicot families are now represented and the monocot house is still under construction. Once this Systematic house is completed this will be a unique facility for the promotion of Plant Taxonomy and Systematics among the students of Botany.

The Hortus Valley

'Hortus Malabaricus' (12 vols.) 1678-1712 is a monumental work on medicinal plants by Van Rheede published in Latin. 742 species of this area are described and illustrated. Almost all the plants discussed in 'Hortus malabaricus' 300 years ago are maintained in the Malabar Botanical Garden with original

illustration from this classic book. This book has been translated to English and Malayalam by Prof. K.S. Manilal when he was working as an Emeritus Professor in the Malabar Botanical Garden.

During the last few years tremendous developmental activities have been successfully implemented, including more than ten research projects funded by various state and national agencies such as KSCSTE, MoEF, NMPB, State Planning Board, DoECC. Research fellows are registered for Ph.D in the Calicut University. National workshops and seminars were organized. Thousands of visitors, mainly students of life sciences from Kerala and nearby states visit the garden every year. A 'Lichen Garden' is in the process of development.

Presently the Government of Kerala is actively considering the up gradation of Malabar Botanical Garden into Malabar botanical garden and Institute for Plant Sciences, a research institution under KSCSTE. It is expected that this institution will emerge into a prestigious research institution in botany education and Taxonomy promotion of our country in the immediate future.

In the shadows of Ebola

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The very existence of life on earth is under constant threat by emerging diseases since ancient times. Highly contagious diseases are implicated as one among the many reasons for extinction of several animal species. The history of mankind was shaped by infectious disease scourges such as small pox, pandemic influenza, plague and cholera. The emergence of novel infectious diseases are initiated many a time by human encroachment and colonization of wild-life habitats, tribal rituals, game hunting and exotic food habits including bush meat eating. The increased urbanization and global travel assist the successful establishment and rapid spread of these infections in the jet age. Some of the recent infections that have spread globally include the avian influenza, swine influenza, chikungunya, dengue, SARS corona virus and MERS corona virus. The latest in the list is Ebola, a deadly viral disease that has gripped many parts of Africa, and spreading to different parts of the world by the return of the disease-affected travelers or health-care workers to their home countries.

Ebola is much more deadly than most of us think. It kills one

in two people that it infects, and in some instances, leaves only 10% of the affected population to survive. And the death due to Ebola is most horrific among the ones caused by hemorrhagic fevers. From its first detection in 1976, about 22 out-breaks of Ebola have been documented. In the ongoing outbreak in West Africa, one of the largest in the history, 4461 laboratory-confirmed cases and 3865 (86.6%) deaths (almost 9 out of 10 persons infected) are documented as of October, 2014.

Let us now look a little deeper into Ebola disease. Among the four subtypes of the Ebola virus that cause disease in human, the Zaire Ebola virus, responsible for the current outbreak is notorious for causation of extreme high mortality. All these viruses look like filaments under an electron microscope and grouped under the *Filoviridae* family as per the virus classification. It would be interesting to know how Ebola virus, confined originally in the cave-dwelling fruit bats in deep dark jungles of Africa, was exposed to the outside world. The human explorations into these unwieldy habitats could be implicated as the starting point. It reminds us the story of the human immunodeficiency virus (HIV), another plague of the modern era, originating from its relatives in the primates and spreading to mankind through human explorations. Entering the bat caves for trapping the fruit bats and getting in contact with their urine and droppings, and eating the uncooked bat meat by tribal people could have spawned the first human case of Ebola. Forest fruits contaminated by the bat saliva can also act as a source of infection. Recent epidemiological studies on the prevalence of anti-Ebola antibodies and its exclusive detection in fruit bats and not in other animals or primates have re-confirmed the bat origin of the virus. Interestingly, the virus survives in bats without causing disease or death in the host, making them the ideal reservoirs.

Once the virus is in man, it is extremely contagious. It takes about 2-21 days to establish an infection and produce the symptoms. The virus is shed only from a person showing the disease symptoms and spreads from one person to another through the direct contact with body fluids. In the virus exposed individual, the disease starts with high fever, head ache, muscle pain, stomach pain, vomiting and diarrhea. In the early stages, it would be very difficult to differentiate these symptoms from many common viral fevers. In due course the patients exhibit severe bleeding and coagulation abnormalities, including gastro intestinal bleeding and body rash.

Virus infects microvascular endothelial cells and disrupts vascular integrity; and subsequently severe liver damage combined with massive viremia result in disseminated intra vascular coagulation. The patient succumbs due to hypovolemic shock and diffuse bleeding. Death may occur in two to three weeks.

Initial diagnosis of Ebola in outbreak settings may be achieved symptomatically but in non-endemic areas, the non-specificity of the symptoms poses a genuine challenge. A travel history to endemic areas coupled with the disease symptoms may be indicative but a confirmatory diagnosis demands resorting to any of the specific tests such as antigen-capture enzyme-linked immunosorbent assay (ELISA), IgM ELISA, polymerase chain reaction or virus isolation. These tests are to be carried out only in centrally designated laboratories with extreme precautions for handling infected samples, and not in primary care settings. Being a highly contagious and lethal virus, virus isolation strictly demands a high-security laboratory with extreme containment of bio-safety level 4 handling. In India, National Institute Virology, Pune, with its state-of-the-art BSL4 facility, is an identified centre for Ebola diagnosis.

Treatment of infected patients is the most challenging part of Ebola disease. With no specific and effective antivirals discovered so far, it demands aggressive supportive care of the patient in an intensive care facility. Access to such facilities is unimaginable in Ebola-endemic regions which are located in some of the economically poorest parts of the

world. It also demands the services of dedicated and altruistic healthcare givers willing to put their own life in peril by nursing the sick patients. Their composure and emotional strength among the war-like scenes of mounting deaths; and untiring efforts in sanitation and systematic disposal of the dead and the contaminated materials will be the back bone of Ebola outbreak management. A patient under very good clinical supportive care and with a robust innate immune response has a better chance to survive. In people who are fortunate to survive an Ebola infection, antiviral antibodies develop that may last at least for 10 years. These observations have prompted the development of preventive vaccines employing various strategies including DNA-based immunization. However, like anti-virals, no successful vaccines are available currently.

With this general overview of Ebola, we need to ponder a little on our perception of the import of disease into India. As of today, India is free of Ebola. However, we can not expect a complete immunity to an Ebola invasion with the presence of around 40,000 Indians in the Ebola endemic regions and also the increased tourist arrivals in India. The pandemic of H1N1 influenza did not take much time to invade the globe and the Chikungunya virus, which was confined to the continents of Africa and Asia till three months ago, has now spread to the Americas. Chikungunya, a mosquito-borne disease, took a little more time than Influenza, an air-borne disease, to spread globally. Ebola, with no air-borne transmission documented so far and its need for direct contact with a person with clinical disease or reservoir animals, may take a much longer time, if at all, to reach India. This window period is a boon for us to enhance our preparedness. Let us empower ourselves with more knowledge on the disease as well as encourage our authorities to keep a vigil on international commuters who have visited endemic countries or had an accidental contact with an Ebola suspected patient. Let us hope to remain in the shadows, not out in the open, to confront the deadly germ of Ebola.

Mangalyan and Indian saga of success

George Varghese,
Director, Kerala State Council for Science technology and Environment

Mars is perhaps the only planet which has captured our imagination profoundly in the entire solar system. Ancestors believed that the red planet might be covered with leafy vegetation and inhabited by people, sometimes more intelligent than us. It was the God of war, *Ares,* for the Greek and *Rudra,* in Hindu mythology. For ancient Romans, Mars appeared as the God of agriculture, which in fact symbolizes its dark and brown texture. Today, we are certain that it is a planet almost like ours, having no animals or plants alive on it. May be it is recollecting its glorified past in deep tranquillity. No wailing sound of wind, chirping of birds, roaring of wild animals, could be heard in the valleys. It is a frozen desert with towering volcanoes and deep canyons. The 19th century Italian astronomer *Giovanni Schiaparelli* was the first to observe straight line like features on the surface of Mars, which he called *Canali*. The term *Canali* was translated into English as channel, which aroused great suspicion that it was an artificial construction made by the intelligent inhabitants. They might have irrigated the Martian soil for better cultivation and these in fact triggered the imagination of writers and philosophers. The canal controversy ended when powerful telescopes came into operation, during the early part of 20th century. The space age, blossomed in the second half of twentieth century, transfigured all our earlier notions about the planet. Mars is now looked in a different angle with a prolonged hope to make it into a life supporting place outside Earth.

Mars is the fourth planet from Sun and the seventh largest in solar system. It keeps revolving round Sun in an elliptical orbit and complete the path in every 687 days. The planet is almost spherical in appearance, and has a mean

diameter 6792 km, which is roughly twice that of Earth. The planet has an axial tilt of 25.2^0, causing seasonal changes in climate. Solar radiations falling on its surface are relatively weaker than on Earth, since it is located farther away; this is 1½ times than Earth-Sun distance. Due to the large distance from Sun, extreme cold conditions prevail, in Mars, with mercury level shoots only up to 17^0C even during the sunniest days. Though the constituents of Mars and Earth are almost same, the matter density of Mars is just 3.9g/c.cm, whereas the same for Earth is 5.9 g/c.cm.

Mars has a very thin atmosphere, comprising mostly of carbon dioxide (~96%), plus a bit of nitrogen, traces of oxygen and water. Another greenhouse gas, methane, is also detected in Martian atmosphere, causing serious doubts about its biochemical origin. Mars has a highly varied and interesting terrain. Its surface has large number of small and large craters formed predominately due to the impact of asteroids and other such heavy objects from outer space. Rift valleys, ridges, hills and plains, volcanoes are the common features found on the surface of Mars.It is believed that Mars has the tallest mountain in the Solar System, called Olympus Mons, which rise up to 24km from the nearby plain. Huge bulging as well as deep canyons are other peculiar Martian features. The reason for this varied and wide spread dichotomy are still unknown.

The detection of methane gas in Martian atmosphere raised many doubts about the history of Mars. Methane is a carbon containing molecule, which has a chemical life time of 300-600 years. The molecule that is observed today, cannot have produced 4.5 billion years ago, along with the formation of the planet. So it implies a possibility that the methane on Mars is biotic. Obviously, there are few possibilities left out for its origin. Some long-extinct microbial organisms might have caused the production of this gas. It remained in frozen condition in the upper atmosphere and temperature variations caused due to climatic changes, have produced the gas from solid methane. A second option hints a very recent process of methane production by microbes. Another theory excludes the possibility of the presences of microbes in Martian soil. Methane may be produced by geochemical processes, called serpentinisation, which is a low temperature metamorphic process involving heat, water and changes in pressure. But this leads to the conclusion that subsurface hydrothermal activity was predominant in Mars. Whether it is biotic or abiotic, the presence of methane indicates that Mars has water in it and it is still a very active planet. An active planet can sustain life and it is always a promising place for explorations and research.

Exploring Mars with multi pronged strategy and by using flyby spacecraft and by robot controlled rovers was started in 1960. The former Soviet Union was the first country to send a space mission to Mars. On 10 October 1960, they sent their space craft, named Marsnik-I on a specially designed rocket, 8K78. The first mission was a failure, due to some technical snag in rocket engine. Journey to Mars is very difficult in many respects. Launching a rocket heading towards Mars any time during the year is difficult. Once in every 780 days, Mars, Earth and Sun appear in specific locations. If a launch is made during this period, the rocket would reach easily in the red planet. The duration of this launch window is roughly 20 days and one has to be very particular in sending rocket during this time. The Soviet people never turned back; instead they tried one after the other, to reach Mars. Unfortunately all of them gone to astray, until they got a partial success in 1962. The National Aeronautics and Space Administrations of US had begun its Mars exploration in 1964 with a flyby mission. The first attempt of NASA was indeed failure due to some malfunction in rocket system. However, their second space craft, Mariner–4, launched during the same launch window, few days after the first, reached safe in the pre-designated elliptical orbit around Mars. This was the first successful mission to Mars. Mariner took close-up images of Mars and sent to the Earth Station. The Soviet scientists repeated their missions but they could not defeat NASA as their further trials also failed in succession. The triumphant NASA after their Appolo Moon Mission started a programme to send a space craft which would ultimately land on

Mars. The mission was named Viking and they sent two space crafts Viking 1 and Viking 2, from their launch station at Cape Canaveral on 20th August 1975 and 9th September 1975. Exactly after 11 months, on 20th July 1976. Viking 1, landed on the surface of Mars. Both the missions were total success. After Viking, they sent many space crafts with improved technology and enabled with sophisticated scientific payloads. Meanwhile, Japan made an attempt by sending a space craft in 1998, using their own technology and instruments. Their maiden attempt also failed to reach Mars. In 2003 European space agency, using a Russian launch vehicle from Baikonur cosmodrome sent a space craft Beagle – 2 to Mars. Beagle reached Mars, but during landing it lost control from the Earth station! China entered into the arena is 2011, by sending an indigenously developed space craft, *Yinghuo* - 1 using a Russian rocket. The rocket which carried Yinghuo -1 could not escape from Earth's attractive field. NASA continued their missions by sending, flyby, landing, and rover missions to Mars. Mars Path finder, Odyssey, Spirit, Phoenix, Curiosity are the major successful missions sent by NASA. Some of them are still performing well, even beyond their targeted durations, on Mars.

The Indian Mars Orbiter Mission *Mangalyan* was indeed a success story in many respects. First and foremost thing is that it had created a history in space expeditions by being totally successful mission in the very first attempt. The second great thing is with respect to the total cost of the project. By all international standards, it was the cheapest mission, without compromising mission objectives or quality of on-board instruments. Thirdly, the *Mangalyan* mission was planned and executed in shortest time period. After accomplishing all these great goals, India had entered into the arena of deep space missions, with proven technology. The spacecraft and its scientific components were developed in ISRO laboratories, proving our capabilities for advanced scientific research. The spacecraft was transported to outer Earth orbit by a PSLV rocket, which was used earlier by ISRO to lift off many massive satellites. It was PSLV's 25th flight. From ISRO – launching pad at Sriharikotta, PSLV–25 took off on 3rd November 2013, carrying *Mangalyan* intact in its 4th stage.

The journey from Sriharikotta to Mars orbit was long and tedious that it took nearly 300 days to complete the trip. The whole journey was controlled and tracked by the ISTRAK – facility of ISRO, located near Bangalore. The PSLV 25 put *Mangalyan* into an Earth bound orbit first within few minutes after lift-off. It was an elliptic orbit, similar to the Moon orbit around Earth. From there, the space craft was pushed slowly by igniting its apogee motors fitted on it, and its path around earth was slowly stretched until it became hyperbolic in shape. The spacecraft after reaching a wider orbit with largest distance 192874 km above earth, a big push was given to it to produce sufficient speed to escape from the attraction of Earth. On November 30th, 2013, ISRO scientist successfully ignited the 440 Newton powerful Liquid Apogee Motor for 23 minutes to provide the necessary thrust to push *Mangalyan* into deep space forever. After this, the space craft continued its journey in a specified trajectory heading towards Mars, but under the attraction of Sun. The geocentric phase of the mission was thus completed and heliocentric phase started. During the lengthiest voyage in deep space the space craft needed no additional pull; therefore the rocket engine was shut off. But it may sometimes happen that the space craft will deviate from the designated path. Under such circumstances small rockets, will be ignited to perform the track correction operation. ISRO has planned four such correction operations during flight time, but they did it only thrice. It was a perfect journey indeed. After 300 days, *Mangalyan* reached close to Mars. The spacecraft experienced the gravitational force of Mars at a distance 573473 km from the planet. Proper tracking, corrections, manoeuvring etc., were necessary to guide the spacecraft into a safe path. On 24th September 2014, scientists had given final commands

to ignite the LAM engine (Liquid Apogee Motor) again, in order to speed down it and to turn it into hyperbolic orbit, after closing the Helios-centric orbit. Two days before, they test fired the engine and found that it was perfect. Early in the morning the rocket started firing. The space craft approached close to Mars and went behind the planet, making it difficult to communicate with Earth station. The distance from Earth was more than 650 million km and, radio signals take nearly 12 minutes to reach Earth from spacecraft. Commands were therefore pre-loaded and the computers on-board had given autonomy to perform operations independently. *Mangalyan* did it well. Rocket engine fired well and *Mangalyan* completed half the round trip around Mars at first, and exactly at 8 AM in the morning it appeared again in the telemetry receivers on Earth. The signal was received at Canbera station from there it was fled to Bangalore. The space craft is in its last phase, called Martian phase, of the mission. This hyperbolic orbit was further shortened to park the space craft into a much closer elliptical path around Mars. Everything went on smooth and the first spacecraft built and controlled from India was now in Mars' orbit.

Mangalyan carries five scientific instruments on-board, which includes Mars Colour Camera for optical imaging, Thermal Infrared Imaging Spectrometer, to map its surface composition and mineralogy, Methane Sensor, Mars Exospheric Neutral Composition Analyser for the study of the constituents in Martian atmosphere and a Lyman Alpha Photometer for the study of the process of water evaporation from Martian soil. All these instruments are small when compared to the large scale analytical laboratory instruments, which is currently active on Martian surface or in flyby missions, operated by NASA. However, they are sufficient enough for the initial studies to understand Mars and its structure. ISRO is switching all the scientific instruments and getting ready for collecting data using these probes.

The Mars Orbiter Mission had placed India into a strategically important position in the world. Space is an area for international co-operation, and for providing technological developments. The whole nation is in great jubilation by the incredible achievement. The *Mangalyan* mission is a saga of commitment, collective decision and efficient management. It is a stimulus for the younger generation, who sometimes keep a negative impression about scientific research in the country and always eagerly waiting for an opportunity to jump into in Western laboratories to carry out scientific research. It had proved that Indian laboratories can be further engaged to make more success stories.

Prof. A. Abraham

- Distinguished scientist, educationist and architect of JNTBGRI

Dr. P.G. Latha,
Director, TBGRI

Professor A. Abraham, the Founder Director of JNTBGRI was born on 25 May 1914. He had his schooling at Chengannur, his native place in Central Kerala. He acquired his BSc Botany and MA Botany degrees in 1st Rank from Madras University. He first served as Economic Botanist of Travancore University at University College, Trivandrum in 1940. He married Ms Grace George, daughter of the then Travancore Chief Secretary, the Late Shri. K. George on January 15, 1945. They have 3 daughters, Nalini, Malini, Ranjini and a son, Suresh. They are all well settled in life by the grace of God.

There was a revival of botanical learning at University College after Professor took charge. He was a very distinguished teacher and his students even now remember his lectures word by word. He instilled into them a sense of admiration and wonder at the botanical mysteries that unfurled before them under his tutelage.

Professor moved on to Cornell University, New York in 1945 as a Government of India foreign research scholar. He acquired his PhD degree in 1948 from Cornell University and did postdoctoral research at Cambridge. He travelled

far and wide visiting the most important agricultural research centres of the world. In 1962, he moved over to Kerala University as Professor and Head of the Department of Botany and Rockfeller Fellow. He was a great researcher, a teacher par excellence, a voracious reader, an aggressive administrator and above all, a wonderful human being. For more than half a century Professor strived for attaining new insights in higher education in Botany. His multifaceted personality leaves an indelible impression in the minds of those who have met him.

Prof. Abraham had a lot of friends in Punjab and Kolkata doing research in plant sciences. He was always a winner, beating his counterparts. Consequently, he established a strong school of cytology in the Botany Department of Kerala University. He always maintained running correspondence with well known personalities in Europe and the US. He later on established several institutions in Kerala and elsewhere thereby helping students of plant science, genetics, plant breeding and horticulture, the last one being the Jawaharlal Nehru Tropical Botanic Garden and Research Institute. The Central Tuber Crops Research Institute, Sreekariyam is another testimonial to his art of institution building.

He was a very far sighted and magnetic personality with a great vision. People with great vision were a breed apart and they always contributed immensely to the development of society. Though the Indian concept of *Vasudhaiva Kudumbakam* treats the entire world and its myriad life forms as members of a family, the burgeoning population and consequent pressure on resources definitely resulted in the rarity or even extinction of many a species from the face of Mother Earth. This human centric approach wherever created always wreaked havoc on other species of the globe to which we are only one of the many species. Plants have been the greatest casualty anytime and anywhere. And our country is no exception. Of the 17,000 species of flowering plants that we have in India, many are on the verge of extinction due to a variety of reasons such as over exploitation, neglect and alteration of habitats and the like.

Prof. Abraham thought of saving such species whose potential, the human race will understand later at a Garden where a series of related studies can also be attempted. He was also instrumental in bringing in many plants into domestication that later proved very beneficial like the tasty variety of Tapioca called Malayan 4 and a host of others.

Prof. Abraham was not simply a teacher. He was very much an acclaimed cytogeneticist, an able administrator, and a horticulturist. He also understood that our country needed more useful plants from other regions. This can be equated with the work of many botanical gardens and pioneer explorers like Nikolai Vavilov. We freely gave many plants to the world in the past like black pepper, cardamom, ginger, teak, etc. We were also benefited from other countries. Indian Botanical Garden at Kolkata was instrumental in bringing the rubber plant to India and the rest of Asia. It changed our economy by supporting the industry. This only shows that botanical gardens can play a pivotal role in influencing the economy of a country.

Botanical gardens existed in human history dating back to thousands of years in the west mostly looking at pleasure and recreation. As centuries passed by the focus and concept of the garden changed dramatically.The present concept is to make it beneficial to mankind by improving his economy. Driven by these ideas, Professor conceived JNTBGRI as a garden meant for the conservation of the biodiversity of the country and also its sustainable utilization. The idea of establishing Jawaharlal Nehru Tropical Botanic Garden and Research Institute was conceived soon after the first United Nations Conference on Human Environment held in Stockholm in 1972 by

Professor. It became a commitment to him to conserve the waning tropical plant species of India in general and of Kerala in particular. It was a daunting and uphill task for him to convince the successive Chief Ministers of the then politically volatile state of the need to have a Conservatory Botanic Garden. Since the state as a whole was considered as a botanic garden, the political leadership did not subscribe to the idea of establishing a garden within a garden. The air got cleared and the Department of Planning and Economic Affairs of the State Government announced the establishment of JNTBGRI in the year 1979 under the aegis of the State Science Technology and Environment Committee. This was followed by the lease of 300 acres of forest land for the garden development in 1982. A visionary that the professor was, his aggressive presentation of garden and research systems as two sides of the same coin exclusively focused on conservation of rare and endangered plant taxa was beyond comprehension and in fact, raised the eyebrows of many in the field at that time. However, he practised what he preached and conservation of orchids and medicinal plants soon became a reality in the garden site at Palode. As an ardent lover of orchids, Professor Abraham was also instrumental in launching the Plant Biotechnology Programme in the Institute in early 1984 for the first time in the state, particularly for the purpose of orchid breeding and multiplication leading to floriculture development. He served as the Director of JNTBGRI from 1979- 1983 and as Chairman of the Executive Committee of JNTBGRI from 1983-1986. Even after he relinquished his office at JNTBGRI in 1983, he continued his visits to the Institute frequently and during those occassions he interacted with the scientists and gave his suggestions and ideas on improving the live collections at the Institute. Incidentally, the first batch of scientists of JNTBGRI appointed in 1983 had the good fortune of being groomed by this great personality. He served as the brand ambassador of JNTBGRI till his sad demise on 20th May 1994, succumbing to a cardiac arrest.

JNTBGRI celebrated his birth centenary during 2013-14 by organizing 12 memorial lectures by eminent scientists and statesmen of the country during the period 25th May 2013-24th May 2014.

The Institute cherishes the fond memories of this great personality and offers humble pranams at his feet.

WE LOVE YOU, PROFESSOR

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