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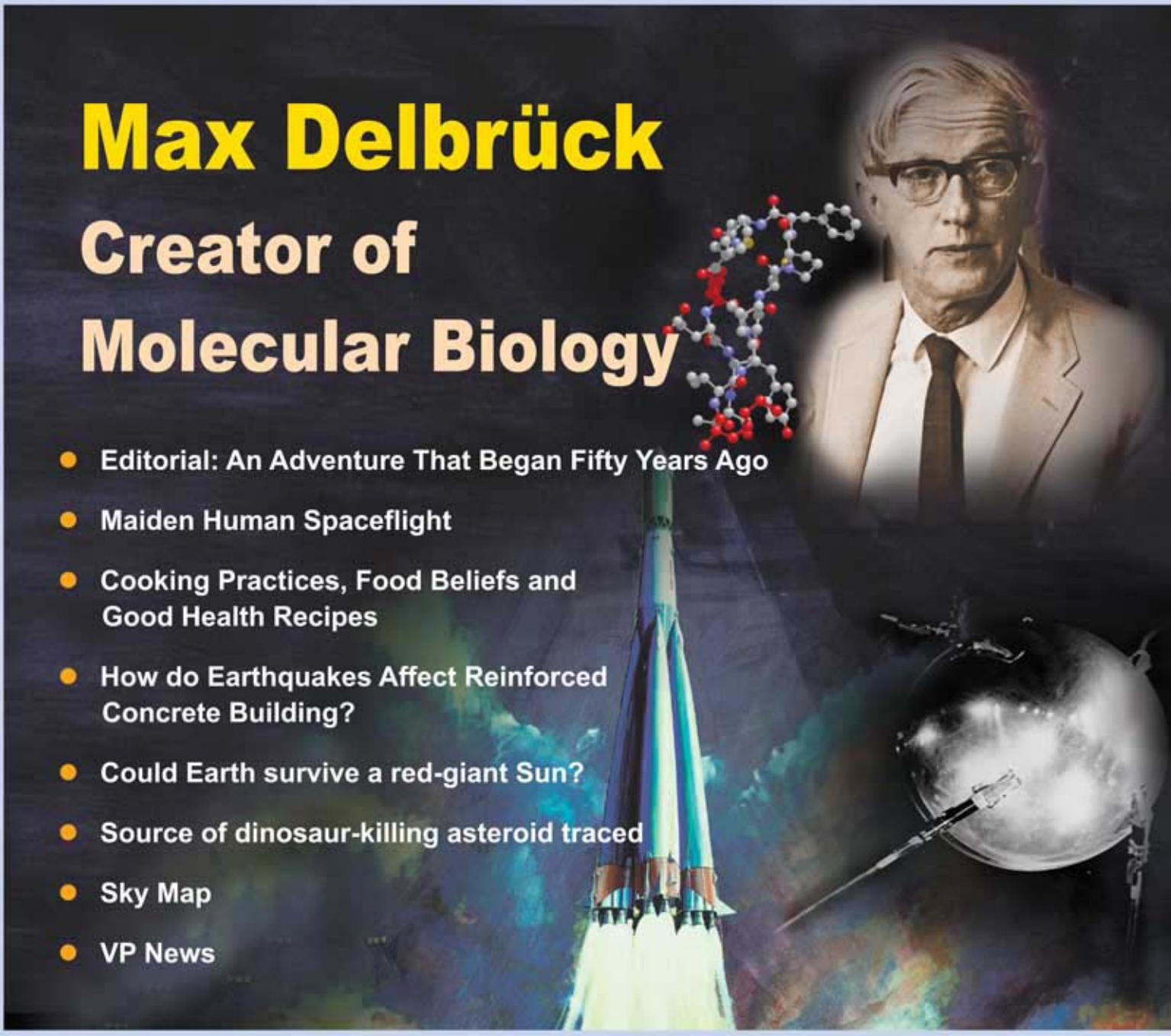

Max Delbrück
Creator of Molecular Biology

- Editorial: An Adventure That Began Fifty Years Ago
- Maiden Human Spaceflight
- Cooking Practices, Food Beliefs and Good Health Recipes
- How do Earthquakes Affect Reinforced Concrete Building?
- Could Earth survive a red-giant Sun?
- Source of dinosaur-killing asteroid traced
- Sky Map
- VP News

... think scientifically, act scientifically... think scientifically, act scientifically... think scientifically, act...

An Adventure That Began Fifty Years Ago

The Space Age began on the evening of 4 October 1957 when *Sputnik*, an 84-kg aluminium sphere of the size of a basket ball launched by the Soviet R-7 ballistic missile, became the first man-made object to orbit the Earth. In mere half a century, humans have orbited the Earth, walked in space, and set foot on the Moon. As of today, the Earth is surrounded with numerous satellites – some 860 of them – operated by more than 40 countries. Many of them are looking towards the Earth, and many have eyes set outwards into the vast expanse of the universe. Our spacecraft have visited every planet in the solar system, and as of now, a probe is heading for Pluto – now relegated to the rank of a dwarf planet.

A month later, on 4 November 1957, the Soviets launched the 509-kg *Sputnik-2* with a dog named Laika aboard. Laika survived only a few hours after the launch in the overheated spacecraft. But, the Soviets made a point. If they could send a dog into orbit, they could send a human being as well. The mission provided scientists with the first data on the behaviour of a living organism in the space environment. Four months after *Sputnik*, the U.S. managed to launch its first satellite into orbit, *Explorer-1*, weighing 16 kg.

The ensuing rivalry produced a series of spectacular achievements and heroes. In 1961, Soviet cosmonaut Yuri Gagarin became the first human in space. The next year, the former marine combat pilot John Glenn became the first American astronaut to orbit the Earth. In 1963, Valentina Tereshkova, a Soviet textile worker became the first woman in space. Cosmonaut Alexei Leonov took the first space walk in 1965. Astronauts Neil Armstrong and Dave Scott performed the first docking manoeuvre. On 20 July 1969, Neil Armstrong and Buzz Aldrin landed on the Moon. With the last Moon mission in 1972 completed, the excitement in human spaceflight waned.

In last 35 years, nearly all human space travel has taken place within low Earth orbit; that is, the region that lies between 200-2,000 kilometres above the surface of the Earth. USA and Russia have had orbiting space stations since 1971. The International Space Station under construction since 1998, however, is the largest international scientific and technological endeavour ever undertaken. The space shuttle is the most complex space vehicle built till date. Incidentally, the boundary between Earth's atmosphere and space lies at about 100 kilometres above the sea level. In 2003, China launched its first "taikonaut" into space, becoming just the third country to send humans into space.

Ever since the last manned mission to Moon, unmanned robotic missions have continued to push the frontiers of knowledge probing the vast expanse of the universe. In 1975, *Venera*, the Soviet probe, descended on Venus through the clouds of sulphuric acid; and braving pressures equivalent of 90 Earth atmospheres and temperatures of about 500 degrees Celsius, transmitting first images of surface of another planet. NASA's *Viking* landed on Mars in July 1976 and transmitted pictures of its surface. Launched in 1977, *Voyager-1* spacecraft visited Jupiter and Saturn, and was the first probe to provide detailed images of the moons of these planets. At a distance of 103 AU (that is, at 103 times the distance between the Sun and the Earth), it is still operational. The rovers *Spirit* and *Opportunity* have been treading the surface of Mars since 2004.

Indeed, these robotic missions have taught us a lot – about Moon, the atmosphere of Titan (the largest moon of Saturn), the fractured face of Enceladus (also a moon of Saturn with a very bright surface), and so on. Flying through the tail of comet Wild-2 the spacecraft *Stardust* revealed what it is made of. A Japanese probe *Hayabusa* landed on an asteroid Itokawa in November 2005, and samples from it containing material from the birth of the solar system will arrive back on Earth in 2010. In case either of these objects threatens to collide with Earth, information from these missions could give us clues to divert or destroy it. *Cassini* has been currently touring Saturn and its moons. Orbiting observatories, beginning with Hubble Space Telescope, have been providing a steady supply of breath-taking images of the cosmos.

True, the space shuttle has been a technological marvel, but, it has proved to be fragile, dangerous and expensive. When *Columbia* disintegrated in 2003 during re-entry, the very relevance of human spaceflight was questioned. And yet, manned space exploration continues to excite us and fire our imagination. This is one reason why U.S.A. has outlined a new "Vision for Space Exploration" to return American astronauts to Moon by 2020 and eventually send them to Mars.

Contd. on page...35

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Max Delbrück
Creator of Molecular Biology

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"Delbrück is unusual in 20th-century science for practicing both physics and biology and for the fact that his place, although substantial as a discoverer, is largely that of an inspirer of others in the creation of molecular biology."

The Cambridge Dictionary of Science (2000)

Max Delbrück began his scientific career as a theoretical physicist. However, inspired by a 1932 lecture by Niels Bohr titled "Light and Life", where Bohr suggested the importance of the Complementarity Principle of quantum mechanics for the understanding of life, he decided to devote the rest of his scientific career to molecular biology. He became one of those who created this new field, and grew to attain an almost mythical status in it."

N. Mukunda in Resonance, November 1999

Max Delbrück (his full name was Max Ludwig Henning Delbrück) was the spirit behind the Phage Group, which began and shaped the field of molecular genetics. He has often been called the founder of molecular biology. Delbrück's own contributions to the understanding of replication and viral function were very significant. Delbrück shared the 1969 Nobel Prize for Physiology or Medicine with Salvador E. Luria and Alfred Hershey "for their discoveries concerning the replication mechanism and the genetic structure of viruses."

Max Delbrück was born on 4 September 1906 in Berlin. His father, Hans Delbrück was a professor of History at the University of Berlin. His mother was the granddaughter of Justus von Liebig (1803-1873), the great German chemist. Max Delbrück grew up in a suburb of Berlin.

Delbrück started his scientific career with the study of novae, the stars, which suddenly increase in brightness. It was a problem in astronomy. However, Delbrück was not happy with the fact that he had to scan the relevant literature in English. Moreover he realized that astronomy in Germany of those days had no bright future. So he finally left this problem and turned his attention to quantum mechanics. His PhD thesis was on the quantum chemistry of lithium. His best-known contribution in physics was in quantum electrodynamics and it is known as Delbrück scattering. He interacted with many of the great German physicists of his time, including Wolfgang Pauli (1900-1958) and Albert Einstein (1879-1955).

Max Delbruck

His PhD thesis supervisor was Max Born (1882-1970), the German-born British theoretical physicist, who pioneered in the development of quantum mechanics. In the summer of 1931, Delbrück went to Copenhagen to work with Niels Bohr. It was made possible by a Rockefeller Foundation Fellowship. George Gamow (1904-1968), the Russian-born American physicist, was also there, when Delbrück came to work with Bohr. It may be noted that Gamow proposed theoretically the genetic code.

It was at Bohr's Copenhagen lab that Delbrück got interested in biology. Following the suggestion of Bohr that his 'complementarity' model might have biological analogues, Delbrück started thinking that by investigating along these lines one might discover new laws of physics. He was much influenced by Bohr's lecture on "Light and Life" that he delivered in August 1932 at an international congress of light therapists. In this lecture Bohr suggested that life processes are complementary to the laws of chemistry and physics. Though, he got interested in biology, his switch over to this field was not immediate. From Copenhagen Delbrück went to Bristol, England.

In 1932, Delbrück returned to Berlin to work with Lise Meitner (1878-1968), who along with Otto Hahn (1879-1968) had discovered the nuclear fission. On his return to Berlin, Delbrück formed a small informal group of biologists and physicists. The group used to meet at his mother's house. His first paper in biology was published in 1935. This paper titled

"On the nature of gene mutation and gene structure" was the outcome of a piece of biological research undertaken by Delbrück in collaboration with the Russian geneticist Nikolai Timofeeff-Ressovsky and the German physicist Karl Zimmer. The paper attempted to throw light on the physical nature of genes. The size of the genes was estimated to be a few thousandths of a millimetre. Variations in mutation rate as a function of temperature was explained with the help of a quantum model of a gene. According to this model genes had several energy states, like a molecule. Genes were stable because they were in quantum mechanical stable states. A mutation was seen as a quantum transition, a passage from one stable state to another. The notions of genes and mutations put forward by this paper have no practical value today. However, the paper was important for other reasons. The paper had endowed physical dimension to genes by linking them to molecular dimensions. Thus it projected genes as things that one could get hold of. The paper, which is also known as "Three-Man Paper", might be regarded

Salvador E. Luria

as the first publication representing collaboration between physicists and biologists. Erwin Schrödinger devoted considerable space to this paper in his book *What is Life?* which influenced many physicists to move into biology.

In 1937, Delbrück got a second fellowship from the Rockefeller Foundation and he went to USA. On 15 October 1937, he arrived at Thomas H. Morgan's laboratory at the California Institute of Technology, Pasadena. He had originally planned to work with Morgan's group in fruit fly (*Drosophila*) genetics. However, he was not happy with *Drosophila* as a model system. He thought it was too complex to reveal the secret of life. He met Emory Ellis, who had started studying bacteriophage or bacterial viruses and who also worked in the same Caltech department as Morgan. Bacteriophages are also called phages. Delbrück immediately got attracted to the idea of working with phage instead of fruit fly. Thus he started working with Ellis at Cal Tech on phage. Delbrück thought phage was particularly suited for the study of the key characteristic of life – self-replication. Phages appeared to be the elementary biological particles. Phages are less than one ten-thousandth of a millimetre in length. Phages infect bacteria and multiply rapidly inside their hosts. Before Delbrück started studying phages, they were widely studied by several groups. The Canadian-born French scientist Felix d'Herelle had discovered phages in 1917 and studied them in detail. The British bacteriologist Frederick Twort and several other groups, particularly at the Pasteur Institutes in Paris and Brussels, and at the Rockefeller Institute in New York followed Felix. In spite of these studies, the nature of phage and its relation to bacteria were not properly understood. Some thought phage was a real infectious particle but others like Albert Krueger and John Northrop "saw phage multiplication as evidence of nothing more than the autocatalytic transformation of an inactive protein precursor that was present in bacterial cells before the addition of the phage." The model proposed by Krueger and Northop to explain phage replication showed an s-shaped or 'sigmoid' kinetic, which was analogous to the autocatalytic activation of enzymes such as trypsin.

Delbrück and Ellis demonstrated that phage multiplication was an irregular process. The experiment conducted by them was in complete opposition to the autocatalytic model proposed by Krueger and Northrop. They did not find any sigmoid curves. They confirmed d'Herelle's findings that phage lay hidden inside the bacterial cell for about 30 minutes and then suddenly liberated in a burst. They interpreted the sudden bursts

Max Born

as bacterial lyses. In 1939, Delbrück co-authored a paper titled *The Growth of Bacteriophage* with Ellis in which they demonstrated that viruses reproduce in one step, rather than exponentially as cellular organisms do. In 1940, he moved to Vanderbilt University, Nashville. In 1945, Delbrück became a naturalized citizen of USA. In 1947, he returned to Caltech and remained there as Professor of Biology till his retirement in 1976.

In 1941, Delbrück met Salvador Luria at a physics congress in Philadelphia, which led to a great collaboration. The following summer they again met at Cold Spring Harbor Laboratory where they had gone to attend the annual CSH Symposium. Their collaboration led to the formation of so called 'Phage Group', which played an important role in the development of molecular biology as a distinct scientific field. The third founding member of the Phage Group was Alfred Hershey, who joined Luria and Delbrück in 1943. Michael Morange wrote: "The term 'Phage Group' refers to all those scientists who, between 1940 and 1960, used bacterial viruses (bacteriophages) as a model system to study how organisms function. The group was never an

organised structure, nor did it have any official existence as such. The research carried out by its members was extremely

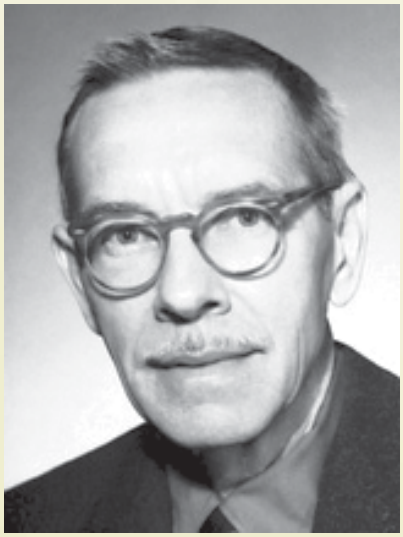
Lise Meitner

diverse and evolved over the years. What gave the group its identity was a state of mind, a new approach to biological problems. This was largely the result of the influence of Delbrück, who is universally acknowledged as the founder and driving force behind the group…This rapid growth of the phage group was partly the result of Delbrück's personal influence, which can be explained in number of ways. Above all his methods were extremely elegant. Using simple statistical tests, he was able to clarify confused questions. His approach also benefited from the prestige that surrounded any technique or concept that had its origin in physics. But most important, Delbrück showed that it was possible to develop a revolutionary approach to biology. The new research dealt with what was specific about life: self-replication. The credo of Delbrück and his colleagues, as set out later, was that the same principles should be able to explain the functioning and reproduction of all organisms, from the virus to mankind."

In 1943, Delbrück and Luria, published their paper titled "Mutations of Bacteria from Virus Sensitivity to Virus Resistance". This research work, often referred to as the Luria-Delbrück experiment, had set out the answer the following questions: How do bacteria acquire resistance to lethal phage? Is it induced by contact, or does it arise from a fortunate mutation? Luria and Delbrück realised that the dynamics of bacterial growth would differ in each case. If the resistance was induced, then one would find greater fluctuation in the number of resistant strains found in bacterial colonies exposed to phage. Luria performed the experiment and Delbrück worked out the statistics. They demonstrated that bacterial resistance to virus infection is caused by random mutation and not adaptive change.

From 1945 onwards Delbrück ran annual summer phage course at Cold Spring Harbor Laboratory, New York, which was attended over the years by most of the leading molecular biologists of the following decade. The first course given by Delbrück took place from 23 July to 11 August 1945. The course was essentially aimed at physicists who planned to enter biology. Participants were required to have a certain level of mathematical ability.

In mid-1950s he turned his attention to the field of sensory physiology. He began to study the sensory mechanisms in the fungus Phycomyces. The fungus grew towards the light, against gravity, and into the wind. Among the



Alfred Hershey

questions that Delbrück and his group answered were: How did the fungus sense stimuli? What range of light did it respond? Delbrück's last published paper in 1981 proposed that the chemical photoreceptor of phycomyces was a flavin and not, as had been supposed, a carotene.

Commenting on Delbrück's love of science and zest for life, Makkuni Jayaram, who worked with Delbrück, wrote: "What was most striking about Max as a scientist was his almost insatiable enthusiasm for intellectual pursuits. Max's oft-quoted riposte to his colleagues,

Frederick Twort

'I do not believe a word of it' was almost always a well-meaning challenge to prove him wrong. Having been shaped in his formative years by the cultural and intellectual tradition of Europe, and having enjoyed the unrestricted freedom to exercise them in America, Max combined the best of both worlds. His mind often transcended the practice of everyday science, and grappled with difficult epistemological, philosophical and even theological questions. He dealt with several of these issues in a course on 'evolutionary epistemology' that he offered to students during his final years at Cal Tech. Thanks to the efforts of Gunther Stent, Peter Fisher, Solomon Golomb, David Presti and Hansjakob Seiler, these lectures (or essays) have been organised into a book titled *Mind from Matter?* The title reflects Max's obsession with the question of how a 'mind' capable of most profound intellectual and artistic pursuits could have arisen from lifeless matter and evolved by a Darwinian process."

While reviewing the book, *Mind from Matter?*, N. Mukunda wrote: "The range of topics covered is breathtakingly vast, all the way from our present understanding of the universe to the emergence of the quantum mechanical understanding of microscopic phenomena; and against this canvas, the formation of the solar system and the planets, and the emergence of life on the earth. Each relatively short chapter gives an incisive account of one or another aspect of this enormous picture…the book is full of treasures, and needs a mature mind to absorb the points it makes. And it needs to be read more than once. The sweep, the grandeur of the canvas are (is) stunning. One may prefer one's own conclusions at the end, but one would have been infinitely better informed by reading Delbrück than otherwise"

References

1. Makkuni Jayaram. Remembering Max Delbrück : The Scientist and the Man, *Resonance*, pp. 21-34, November, 1999.
2. Vidyananda Nanjundiah. Delbrück 's Publications in Biology, *Resonance*. Pp.35-53, November 1999.
3. Max Delbrück . A Physicist Looks at Biology, *Resonance*, pp.89-102, November 1999 (Reproduced from J. Cairns, G. S. Stent, J. D. Watson, Eds. *Phage and the Origins of Molecular Biology*, Cold Spring Laboratory of Quantitative Biology, New York, 1966).
4. Max Delbrück . A Physicist's Renewed Look at Biology: Twenty Years Later. *Science*, 168, 1312-1315, 1970.
5. Michael Morange. *A History of Molecular Biology*. New Delhi: Oxford University Press, 1999.
6. Horace Freeland Judson, *The Eighth Day of Creation: The Makers of Revolution in Biology*, New York: Simon & Schuster, 1979.
7. Erwin Schrodinger. *What is Life?* New York: Cambridge University Press, 1992.
8. Ernst Peter Fischer and Carol Lipson, *Thinking about Science: Max Delbrück and the Origins of Molecular Biology*, New York: W. W. Norton, 1988.
9. J. L. Heilbron (Ed.). *The Oxford Companion to the History of Modern Science*, Oxford: Oxford University Press, 2003.
10. *A Dictionary of Scientists*, Oxford: Oxford University Press, 1999.
11. David, Ian, John & Margaret Millar. *The Cambridge Dictionary of Scientists* (Second Edition). Cambridge: Cambridge University Press, 2002.
12. Available sources on the Internet.

(This article is a popular presentation of the important points on the life and work of Max Delbrück available in the existing literature. The idea is to inspire the younger generation to know more about Delbrück . The author has given sources consulted for writing the article. However, the sources on the internet are numerous and so they have not been individually listed. The author is grateful to all those works have contributed to writing this article.)

Editorial *(Contd. from page...39)*

The U.S. is ordering new rockets, building new spaceships and preparing plans for a permanent base on the Moon. NASA has also embarked on an ambitious programme "Constellation" to build a space transportation system that can not only carry humans to the Moon and back, but also resupply the International Space Station and eventually place humans on Mars. We may note that NASA wants to retire space shuttle by 2010. The *Orion* crew exploration vehicle is a key component of the Constellation programme – which contains a pressurized capsule, life support systems, and a propulsion engine. Ever since the programme was established in 2006, NASA and their partner Lockheed Martin have been working on development of the new rocket launchers, crew and service modules, and upper stages and landing systems. Indeed, NASA Administrator Michael Griffin expressed the hope during the recently concluded 58th International Astronautical Congress at Hyderabad that in 2037 humans will set their foot on Mars.

It would be of interest to note that the space-faring nations including Russia, China, Japan and India are also considering human flights to Moon and beyond in due course of time. India is all set to send its unmanned mission *Chandrayaan* to orbit Moon. However, as the experience with the International Space Station has shown, if such efforts are to be sustained, cooperation among space-faring nations would be vital. Surely, it makes sense to pool resources, both technical and financial, in such expensive ventures.

What would be our goals for exploring the solar system, anyway? Monitoring Earth's climate, preparing a defence system against possible collisions with asteroids, continuing the search for life search for life and origins of life on Earth, understand the origin of the planets, and beginning development and testing technology for an interstellar probe. We could look for minerals on asteroids, or even look for new sources of energy, say tapping the rich reserves of He^3 found on the surface of Moon, and regarded as an ideal fuel being non-polluting and having virtually no by-products.

Exploration or scientific research is a gamble, and it cannot be expected to pay back in the short term. But, in due course, it could pay back handsomely, as history has shown time and again. Communication satellites have helped bring cricket and football world-cup matches, wars, and celebrations from thousands of kilometres away into our living rooms. They have connected the world through a network of telecommunication satellites. Weather satellites warn us about impending cyclones or hurricanes; and global positioning system (GPS) satellites save us from getting lost on unfamiliar streets. Today we have billion-dollar industries based on telecommunication and GPS satellites. All this due to an adventure that began fifty years ago with an 84 kg metal ball shot into space.

Satellites have allowed a country like India to provide communications and remote sensing services to people in the remotest corners relatively cheaply and quickly. It is hard to imagine all this happening without space. We could have a computer, but we would not be able to get on the internet. Space exploration has brought us several benefits. This is why many countries are in the process of developing ambitious programmes on space exploration and benefit through the applications of the space technology. It may not be a quick-fix solution to raise people above the poverty line, or improve their health, but would certainly assure the nation of a prosperous future. What is more, it could give people a vision of future and help attract young people to study science and engineering.

Surely, it is possible to make a better life for everyone on Earth, and at the same time to reach for the planets and the stars, as Carl Sagan once said.

Vinay B. Kamble

Maiden Human Spaceflight

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Launch of Vostok-1

Uzmoriye, a village on the Volga River was as idyllic as any other. People were about their work, tending cattle, caring fields, collecting wood from the forest. Time appeared to move slowly. Like any other day, Anna Tahktorovna and her six-year-old granddaughter Rita were in the forest gathering twigs and wood. All on a sudden, a weird looking object dropped from the sky – orange in colour, it had the appearance of a parachute. They were terrified at the menacing looking weird thing that walked out of the orange bloom towards them. Fearing for their life, these two simple village folks ran like hell. They picked up courage, calmed down and made an effort to stop only when it addressed them in Russian, "Mother, where are you running? I am one of yours, a Soviet, don't be afraid, don't be scared, come here…I want to find a telephone; I have to call Moscow"

That was indeed Yuri Gagarin, who had parachuted to Earth near the settlement of Uzmoriye on the Volga River after his maiden spaceflight, making history. He explained to the peasant women how, he a Soviet air force pilot, had been launched into space by the Soviet rocket *Vostok-1*, and how after completing one round of Earth in space he had landed safely. Stunned at hearing that Gagarin had returned from spaceflight, the peasant women wanted to know if he met angels in his trip! Rolling up on motorcycles villagers came to help. Soon search parties arrived. Both the village and Yuri Gagarin earned a place in history.

The historic mission was not announced to the world prior to the launch by the Soviets; Korolev and others waited anxiously for the mission to succeed. Only after it was confirmed that Yuri Gagarin was safe in the orbit, the Soviets informed the world with a cryptic news bulletin. The whole world was stunned at the Soviet space feat. Common people the world over gathered around radio to hear the human voice from space. The road to stars seemed to be around the corner.

Road to space

Road to space was not a royal path, in particular human spaceflight was arduous and had to face many challenges. The Soviets had to face several hurdles and solve a number of technical issues before they could put a human in orbit. At first, the authorities in Soviet Union did not realise the importance of the *Sputnik-1*, the first artificial satellite they had launched

Yuri Gagarin first human in space

in 1957. In fact the national newspaper, *Pravda* gave just a small news item in one corner of the first page to report the launch of *Sputnik*. Only after the western media splashed headlines and made much about it, Nikita Khrushchev, Premier of the Soviet Union, realised the import of the event. He immediately ordered that another space feat be accomplished to commemorate the 40th anniversary of the October Revolution, just a month away. All the employees who had gone on much deserved vacation after the successful launch of *Sputnik-1* were hurriedly called back to report to duty on 11 October 1957. They were charged to make preparation for the next flight; this time carrying a living being to space.

Although launching a living being to space was a sudden decision, the Soviets were in fact preparing for that occasion for many years. The Soviet Union was conducting several experiments since 1950s to understand the physiological effect of high altitude and weightlessness. Institute for Biomedical Problems in Moscow under the directorship of legendary Oleg Georgievich Gazenko used free-fall from high-altitude balloons to carry out tests on animals and humans. Animals, usually dogs, were placed in the nose cone of missiles and were launched to upper atmosphere and the passengers were recovered using parachute to study the effect of the G forces and other physiological effects. For the first time on 22 July 1951, two dogs named Dezik and Tsygan were catapulted to sub-orbital space (reaching space, but not actually orbiting Earth) in the nose cone of a R7 missile. Both dogs were recovered unharmed after travelling to a maximum altitude of 100 km.

Dogs were the preferred animals because Soviet scientists felt that they are

Yuri Gagarin with his wife Valentinna Goryacheva

better suited to endure long periods of inactivity. Stray dogs and in particular females were chosen. Pet dogs would have got accustomed to living in a house whereas stray dogs would have endured and would be able to tolerate the rigours and extreme stresses of spaceflight. Unlike male dogs, female dogs did not need to lift a leg to urinate! As part of their training, dogs selected for the tests were confined in small boxes for 15-20 days at a time. Their training included standing still for long periods of time, wearing space suits, being placed in simulators that acted like a rocket flight; riding in centrifuges that simulated the high acceleration of a rocket launch; and being kept in progressively smaller cages to prepare them for the confines of the space capsules. Dogs that flew in orbit were fed nutritious gel and were trained for different dietary habits.

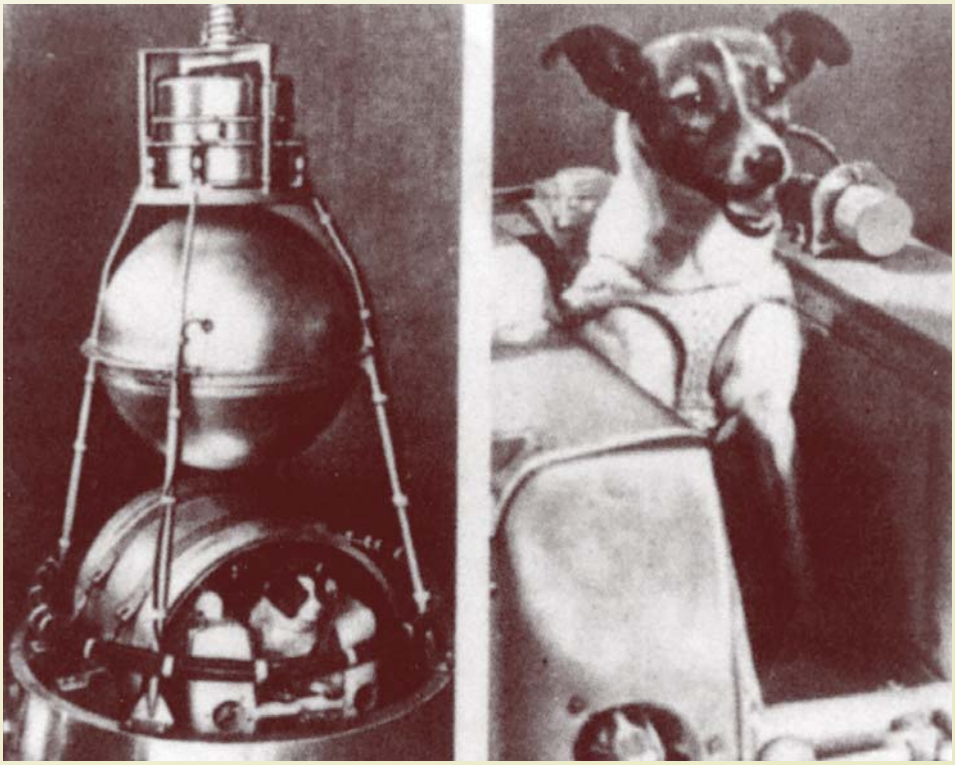
Laika

As the deadline provided to them was very short – in fact, only a few weeks – Soviet engineers had to compromise on various aspects. *Sputnik-1* proved that the Soviets obviously had the means to launch a satellite but still lacked the technology to successfully return a payload from Earth orbit. As a result, recovering the passenger was not an option that was available at that short notice. Hence as an "engineering compromise", it was decided that a dog could be carried in a relatively simple pressurized cabin similar to those used earlier in the ballistic rocket flight tests. *Sputnik-2* was hurriedly built as an unstabilized satellite without any complicated attitude control system to meet the deadline.

While cabin designs to carry dogs safely in missiles had been studied and flown on short ballistic flights, hardware required substantial modifications for spaceflight. Ride on a missile typically lasted for few minutes, but journey to space would require adequate onboard systems that could keep the passenger alive for at least a little over a week. To meet these demands, satellite designers included a food dispenser to supply the dog with a balanced diet of food and water in a gelatinized jelly form. A much more advanced air regeneration system to maintain proper oxygen levels in the cabin was developed. The padded cabin interior was quite cramped but there was enough room for its passenger to lie down, sit, or stand. Designs were made at breakneck speed.

Instead of a rudimentary radio transmitter and telemetry system in *Sputnik-1*, a much more sophisticated telemetry system, called 'Tral-D', capable of handling large volumes of engineering and bio-telemetry was placed in *Sputnik-2* (called by its technical name Object PS-2). Further, in order to conserve its batteries, Tral-D was programmed to transmit data for only 15 minutes during each orbit, when the satellite would be over the Soviet Union. The mission was also to carry a pair of spectrophotometers to study solar ultraviolet and cosmic soft X-ray emissions. Finally, *Sputnik-2* was equipped with a slow-scan television camera to observe its passenger. This system was capable of transmitting ten 100-line video frames per second back to the ground. All together *Sputnik-2* was roughly conical in shape with a height of four metres and a base diameter of two metres. Six times more massive than *Sputnik-1*, the new satellite *Sputnik-2* weighed 508.3 kilograms.

The dog chosen to ride into orbit was female dog Laika (Barker) weighing six kilograms. Dogs of this breed were considered ideal for spaceflights due to their small size and even temperament. Before launch, Laika was carefully groomed by attendants and electrodes were attached to her body to monitor her respiration and heartbeat. A rubber bag



Laika in Sputnik - 2

was also strapped to her hind quarters to collect waste. Finally she was fitted with a special harness and secured inside the cabin of *Sputnik-2*. On the morning of 3 November 1957, just three days prior to the Russian Revolution anniversary, *Sputnik-2* was successfully placed into a 225 by 1,671 kilometre orbit inclined at 65.3 degrees to the equator with a period of 103.75 minutes.

Originally the *Sputnik-2* mission was to last for about ten days after which Laika would die of asphyxiation. The Soviets kept a close watch on Laika, especially its vital functions. They wanted to make certain that space environment is conducive for humans to venture and that there is no unknown lurking danger. The physiological variables of Laika were monitored and sent back to Earth included electrocardiogram, blood pressure, respiration rate, and motor activity. Readings received after the satellite reached its orbit indicated that Laika was eating, but that she was agitated and barking. Investigations revealed that as planned the nose cone had jettisoned after reaching orbit but the last stage of the rocket booster remained attached. As a result, the thermal regulation system could not operate properly. Because of this and as some thermal insulation that was ripped away, the temperatures inside the cabin quickly soared to as high as 40° C. The dog's vital signs indicated that she was frightened but had survived the trip to orbit. However, it is believed that Laika perished after about 10 hours in orbit. *Sputnik-2* itself continued to transmit until a week after its launch. After Laika, many dogs were launched before the Soviets dared to send a human into space orbit. Of course all the other dogs were recovered. Though Laika died in space, the historic flight of *Sputnik-2* proved that extended periods of weightlessness were survivable and thus opened the way for human exploration of space.

If Laika was left to die in the space due to engineering limitations, the Soviets perfected recovery systems soon. Two dogs Belka and Strelka spent a day in space aboard Sputnik-5 on 19 August 1960 before safely returning to Earth, thus proving not only launch but safe recovery is possible. Subsequently Pchelka and Mushka, two dogs from the flight squad spent a day in orbit on 1 December 1960 on board *Sputnik-6*. They were accompanied by a grey rabbit, 40 mice, two rats, flies and a number of plants and fungi. All passengers survived. However, the initial success ended in a tragedy as the spacecraft disintegrated on re-entry and all the passengers died on 2 December 1960. This cautioned the Soviets of the perils of the spaceflight.

Suitably chastened by the initial tragedies, before embarking upon the first manned spaceflight, the Soviets sent dogs in 29 rockets and with passenger slots for at least 57 dogs to ensure the safety of the first man to make historic spaceflight. Some dogs made more than one space ride. During the launch or re-entry 10 dogs died, including Laika. Only after gaining experience on manoeuvring the spacecraft safely back to Earth, and sustaining life in the harsh inhospitable environment of space did the Soviets send the first human into orbit. In fact, just before Yuri Gagarin was launched, on 9 March 1961, a dog named Chernushka was launched along with a dummy in a very similar Vostok spacecraft. Both the dummy and the dog returned safely to Earth. Once again a dog named Zvezdochka was sent along with a wooden cosmonaut dummy to orbit on board *Sputnik-10* on 25 March 1961 in the final practice flight before Gagarin's historic flight on 12 April. Again, the dummy was ejected out of the capsule while Zvezdochka remained inside. Both were recovered successfully, thus increasing the confidence of the Soviets.

Even after the launch of the first humans into space, dogs were routinely sent so as to study the effect of microgravity, effect of spaceflight and prolonged weightlessness. Veterok and Ugolyok were launched on 22 February 1966 on board biosatellite *Cosmos-110* (satellite primarily designed to study biological effects of spaceflight), and spent 22 days in orbit before landing on 16 March. During the mission the dogs were observed in orbit via video transmission and biomedical telemetry. Astronauts who went on spaceflight in *Skylab-2* in June 1974 were the first humans to exceed this feat by dogs; in fact this still stands as the longest spaceflight by dogs.

High Drama in the Space

The number of rocket failures that beset the Soviet efforts impelled them to conduct mock tests before they embarked on actual human spaceflights. With a view to testing their launch system, spacecraft, as well as the recovery capsule, Soviets had sent dummy human figures, wearing tags printed with the name *Ivan Ivanovich*, to space. The dummies flew in *Vostok* capsule test flights from Baikonur Cosmodrome in Central Asia. The dummies were dressed in real space suits and their capsules carried tape-recorded messages to simulate two-way radio. The messages were combinations of letters and numbers. The taped transmissions, overheard around the globe, led to rumours that a cosmonaut had called for help from an out-of-control spacecraft. Most of the dummy test capsules landed as commanded, bouncing down at various sites in Central Asia where they were found by local residents. Seeing lifeless dummies in space suits, those residents spread rumours that cosmonauts had died. Though unfounded, the legend still lives on that there were secret missions by Soviets before Gagarin, which were failure and hence hushed up.

First manned flight

Yuri Gagarin was born on 9 March 1934 in the village of Klushino about 150 km west of Moscow, situated near the town of Gzhatsk in Russia. With Alexei Ivanovich, a collective farmer as his father and Anna Timofeyevna, a dairymaid as his mother, Yuri was from a humble background. Like most children of his generation his schooling was interrupted by the Nazi invasion. The Gagarin's house was occupied, and family had to live in a dug-out. When the Germans retreated, they took two of Yuri's sisters, who

returned only after the Second World War ended. Gagarin re-commenced school after the war and his favourite subject was arithmetic, and he also developed a keenness for science. On finishing school in 1950, Yuri enrolled in an industrial school at Lyubertsky, near Moscow to study foundry work. Students at the school combined factory work and study while they prepared for jobs in Soviet industry. While being trained as skilled worker he also attended evening classes to pursue higher studies.

Having excelled in his studies Gagarin was given opportunity to join a four-year technical school where he could finish his secondary education while he also studied foundry work. His new school was in Saratov, a town near the Volga River; most importantly there was an airfield and a good flying school nearby. Gagarin was enthralled by flying machines; and as opportunity appeared, he enrolled in the flying school. He had to study for his secondary education while at the same time learn skill of foundry work and flying an airplane. His heart was in flying. His course included a parachute jump, feared by most other flying club students. But Gagarin eagerly awaited his chance and after his first successful jump he remarked that the first flight filled him 'with pride and gave meaning to his whole life.'

After graduating from the flying school, Gagarin was inducted into Soviet Air Force where he commenced his carrier as a fighter-pilot. His first posting was at Orenburg where he met his future wife. Valentinna Goryacheva was nursing student and a postal worker at Orenburg and they met by chance at a railway station. It was indeed fairy tale love at first sight. Those were his carefree days. He recalled "My priorities then were my hair, flying school and chasing Valentina… I liked everything about her; her character, her small height, her bright hazel eyes, her small, slightly freckled nose, and her plaited hair".

By then the Soviet Union had demonstrated its capability to put a satellite in orbit; and was readying to put a human in space. Soviet military was selecting suitable young people to be trained for spaceflight. In 1959, Gagarin was invited to apply for a cosmonaut training school. He was called up, along with several dozen other candidates before a medical board. The competition was very intense. On his 26th birthday, 9 March 1960, he received the news of having been selected for cosmonaut team. He was one of the first 20 or so pilots selected for spaceflight training. However his training for spaceflight was kept so secret that even Valentina did not know about it! Only weeks before the launch, Gagarin told Valentina that he was not only training for spaceflight, but had been chosen as the first man to fly.

Petty fruit flies are the first animals sent into space when they were launched abroad U.S. made V2 rocket in mid July, 1946 along with corn seeds. Unmanned spacecrafts had indicated the presence of strong radiation belts at high altitudes and the experiment was designed to study the effect of exposure to these ionising radiations. Other V2 missions of US carried biological samples, including moss to study the effect of UV rays and increased radiation.

Yuri Gagarin with Pandit Jawaharlal Nehru (first Prime Minister of India)

On 12 April 1961, at 9:07 a.m. Moscow time, *Vostok-1* was launched from Tyuratam launch pad. Two minutes into Gagarin's flight, four boosters strapped to the core of the rocket separated and fell away. Half a minute later a protective shroud covering *Vostok* was jettisoned. At five minutes, the core booster burned out and the final stage rocket ignited. Final stage shut down as *Vostok* reached orbit 11 minutes 16 seconds into the flight. *Vostok-1* made just one revolution, though food water and life support system was geared to last for over 12 days. Retro-rockets were to fire to bring the spacecraft safely to Earth. However, not taking any chances with their maiden human flight, Soviet engineers had made the orbit such that orbital decay would naturally bring the spacecraft home even if the retro-rockets had failed. Inside the re-entry capsule was an ejection seat for the cosmonaut, three viewing portholes, film and television cameras, space-to-ground radio, control panel, life-support equipment, food and water. Two radio antennas protruded from the top of the capsule. The flight was controlled from the ground.

Soon after the lift-off, as pre programmed the first stage jettisoned, Sergei Korolev and others were impatiently awaiting report from Gagarin on his entry into space. However the speakers were as silent as graveyard. Fearing mishap Korolev kept on calling Gagarin 'Cedar How do you feel' (Cedar was the code word for Gagarin); Cedar answer me…' No reply came for several moments. Korolev kept on calling with anxious concern. Still no reply came. Then suddenly Gagarin's excited voice could be heard "I see Earth. It is so beautiful'. The endless worries were over; Gagarin had indeed reached space safely.

By 10 am Moscow time, Soviet news agency TASS had released the news of the successful launch of first human into space. World over there was furore. Newspapers hurriedly changed their layout to accommodate the breaking news. "Soviet Union was the first to launch an artificial satellite in 1957, a Moon probe in 1959, and the first to return living animals from space last year. It has now given its own Christopher Columbus of space to the world" commented a French news agency. Hermann Oberth, known as father German rocketry, told the reporters that he had indeed predicted that humans would travel to space in 1923, however, he had expected the first person to reach space to German. He stated that on 4th October 1957, when the Soviets launched *Sputnik-1* he decided that the first man to enter space would be a Soviet. On hearing the news on radio, Gagarin's sister Zoya rushed to their mother excitedly. 'mother' she called out 'switch on the radio… they are talking about Yuri'. Stunned, Anna Gagarina, mother of Yuri gasped 'an accident'. Zoya replied 'No he is in space'. Exacerbated Anna started to cry 'What has he done, he has got two kids, two daughters'.

The celebrated spaceflight of Gagarin was just one orbit of Earth. The space capsule circled the Earth and after 18 minutes of launch, the spacecraft moved towards North Pacific, 30 minutes after the launch, it entered into sunset and subsequently into the night side of Earth. 41 minutes after launch the spacecraft crossed the equator at 170° west. Nine minutes later it was above America. 53 minutes after launch it was crossing the tip of South America. At 63 minutes, once again the spacecraft entered the day side of Earth. Gagarin could see a magnificent sunrise from space.

Subsequently *Vostok* was turned into position so a braking rocket could fire the rockets in a direction opposite of the flight to slow it down and cause it to fall back into the atmosphere. At 78 minutes, when the capsule was above Angola in Africa, the retrorocket was fired for exactly 42 seconds. The instrument module separated from the capsule. Re-entry began ten minutes later. Soon the spacecraft entered Earth's atmosphere. Due to friction the outer coating of the capsule heated up and burnt. As planned, at 108 minutes, Gagarin ejected himself from the capsule at an altitude of 7,000 m. He separated from his ejection seat at 4,000m descending via parachute. The historic mission lasted 118 minutes from launch to landing.

Sergei Krikalev

Though the mission ended in success and the Soviets were confident, they were very nervous. Through the telemetry they were constantly monitoring the status of Yuri Gagarin. The acceleration during the launch exceeded 5 G but did not prevent Gagarin from communicating with the ground. Once in orbit he described the appearance of the Earth and the unexpected complete blackness of the sky. During the flight a number of physiological variables were monitored, including electrocardiogram, respiration rate and chest movements. A television camera recorded the cosmonaut's activities. The spaceflight removed any misgiving that may have remained regarding the possibility of manned spaceflights.

Upon his return, Gagarin was awarded the title of Hero of the Soviet Union and received the Order of Lenin, highest honour bestowed in the Soviet Union. He made many tours of the world, and was showered with honours and awards in recognition of his great feat. A crater on the far side of the Moon was named in his honour, and during a visit to London, he was presented with a Gold Medal from the British Interplanetary Society.

But the hero adored by one and all around the globe died in a plane crash in 1968, at a young age of just 34 years. Seven years after his historic 1961 flight, Gagarin and co-pilot Vladimir Seryogin were training for the spaceflight on board *Soyuz-3*. On the fateful day of 27 March 1968, they had just taken off from a ground field in a MiG-15 training airplane as part of their training exercise, the plan crashed and they were killed.

Gagarin's mission was but a small step, just one orbit around Earth. Space travel has come a long way from the short single-orbit mission to multi-year operations of manned orbital stations. Shortly after Gagain, to test the endurance level of spaceflight, Valery Bykovsky spent 4 days and 23 hours solo in *Vostok-5*, between 14 and 19 June 1963. Subseqnetly Valeri Polyakov, launched on 8 January 1994 (*Soyuz-TM-18*), stayed on board *MIR* space station for 437.7 days, during which he orbited the Earth about 7,075 times and travelled about 300,765,000 km before returning to Earth on 22 March 1995 (*Soyuz TM-20*). Sergei Krikalev has logged cumulative total of 804.371 days in space (as of July 2007) making him the topper. Indian decent, Sunita Williams logged 195 days in ISS to become longest space stay for a women. In total all the cosmonauts, astronauts of all the countries put together humans have spent about 30,000 person days in space, all in just last fifty years! ■

Cooking Practices, Food Beliefs and Good Health Recipes

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Long ago, as man evolved from his humble wilderness origins, he began to savour the warmth of glowing coals. The light of fire gave him strength over other animals and brought him into company of other men. It was perhaps in this socio-psychological setting that he began to roast and cook food in a bid to infuse food with added energy. As time went by, and life became more complex, he found numerous ways to process and prepare food. While these cooking processes certainly did add to his palate-tickling delight, some left the food itself barely recognizable. Not just heat, other techniques of food preparation, be it simple washing, chopping, marinating, or fermentation alter the nutritive value of food in a significant way.

Even though the school of naturopathy would prefer us to return to the age of our ancestors and live on raw natural food, creative food preparation integrated with a basic understanding of the chemistry and physics of cooking can be yummy for the palate and at the same time healthy from the nutritional standpoint.

Cut off the pre-cooking nutrient loss

Several pre-cooking practices can affect the nutritive value of a food. Even the seemingly innocuous practice of preliminary washing before cooking can in many cases cause a major loss of minerals and vitamins. Rice, a major component in diet in this part of the world, is one such example. Washing it with a large quantity of water can deplete as much as 40 per cent of its thiamine and niacin content. The loss does not stop here. Discarding the excess water from boiled rice before serving, also leads to loss of vitamins. There is an easy way out. Use as little water as possible for washing and leave just sufficient water in the pot before cooking such that all of its absorbed during the cooking process.

Chopping vegetables into small pieces and leaving them on the kitchen shelf for a long time before cooking, is also not a healthy practice. The smaller the pieces and longer the time lag before a vegetable is cooked, more is the exposure to air. This results in oxidation and loss of vitamins. The loss is most in case of vitamin C. You could stymie this loss by bringing in a few positive changes in your kitchen routine. Chop vegetables into large pieces. Never leave them on the kitchen shelf for much long. Put them through the cooking process straight away. Leaving chopped vegetable pieces soaked in water for long is one more way to lose water-soluble nutrients. They leach out into water.

Not that all pre-cooking kitchen traditions work negatively! The routine of using sprouted foods and fermentation, such as during preparation of *idli*, *dosa*, *dhokla*, improves both their digestibility and nutrient content. The content of vitamin C and those of the B-complex group stands much enhanced.

Adopt a healthier cooking routine

When it comes to vegetables, they are best cooked on low heat in a covered vessel using as little water as possible. This helps preserve their nutrient content, reduces cooking time and improves their flavour. Excessive heating also compromises their nutritive value.

Baking soda is often added to *dhals* (dried beans and lentils) to hasten the cooking process. This routine is best discarded because it leads to unnecessary loss of vitamins. Likewise, avoid boiling the milk after adding jaggery to it. This causes loss of protein and lowers the nutritive value of milk.

Some cooking practices also enhance food value. The addition of tamarind, *amchoor* and other acids at the time of cooking, a common culinary custom in Indian homes, protects against

vitamin loss. Besides making food more appealing to the palate, boiling, steaming, frying, roasting and baking also work to destroy potential disease-causing microbes in food. These processes also improve the digestibility of certain foods. For example, the digestibility and protein quality of soybean is considerably improved on heating since it helps destroy the trypsin inhibitor, an enzyme which interferes with its protein availability. Likewise, boiling an egg eliminates avidin, which is known to bind biotin (a vitamin) and make it unavailable. Cooking also makes it easier for us to digest starchy foods.

Fruit skins and their health significance

Even though the rampant use of pesticides makes edible fruit skins a suspect, it is best to consume fruits without peeling them after a thorough wash. Rinds of apples, guavas, plums, pears and several other fruits provide among other useful things, dietary fibre that offers several health advantages. They facilitate proper bowel function and cut the risk of constipation, diverticular disease, and colon cancer. They also exert a healthy influence on blood cholesterol and blood sugar numbers. While rinds help lower the harmful low-density lipoproteins, they also limit sudden spurt in blood sugar soon after a meal.

The healthier milk

Milk is a wonderful wholesome food. It is an excellent natural source of protein, fats, lactose, most vitamins, and minerals including calcium, phosphorus, sodium, potassium, magnesium, copper, iodine and cobalt, thus, making it a fine blend of all nutrients necessary for growth, development and maintenance of the human body.

It is common belief that pure milk is far healthier than the fat-free skimmed or toned milk sold by cooperative dairy outlets, because it has more strength. There is no disputing the fact that gram for gram whole milk contains much larger amount of fat and calories than skimmed milk; however, for most children and grown up people, it is best that they take less fat and fewer calories. Saturated fats, contained in whole milk, are not very healthy and should ideally be restricted to no more than 10 per cent of the daily calories.

Take a look at the nutritive value of different natural human and animal milks:

Nutritive Value of different Milks (Value per 100 grams)

Nutrient	Buffalo Milk	Cow Milk	Goat Milk	Human Milk
Fat	6.5 g	4.1 g	4.5 g	3.4 g
Protein	4.3 g	3.2 g	3.3 g	1.1 g
Lactose	5.1 g	4.4 g	4.6 g	7.4 g
Calcium	210 mg	120 mg	170 mg	28 mg
Water	81 g	87 g	86.8 g	88 g
Energy	117 calories	67 calories	72 calories	65 calories

Fats and oils in cooking

Which cooking medium would you think is best? The vexing question is certainly not an easy one to answer. Over time, nutritionists have come up with different prescriptions. The present consensus is that it is best to keep all fats and oils to the minimum, and visible fats be restricted to a maximum of two or three tablespoons a day. This daily allowance is best distributed equally between saturated fatty acids (SAFA), polyunsaturated fatty acids (PUFA), and monounsaturated fatty acids (MUFA).

What this translates in simpler terms is simply this:

- Use olive oil, mustard oil, or groundnut oil for their high PUFA content;
- Employ sunflower oil, safflower oil, or corn oil for their high MUFA content; and
- Butter and ghee – if you wish to take your fill on SAFA. Palm oil and coconut oil are also high on saturated fatty acids, and therefore must be watched against.

Just so that you may understand the rationale of this exercise, here is a break up of percentage of fatty acids in common cooking mediums:

In general, the more the SAFA content of a cooking medium, higher is the cholesterol rise associated with its use. Coconut oil is the most notorious of all. It causes the maximum rise in the unhealthy low-density lipoproteins (LDL), has a high tendency to promote fat deposition on the arterial wall and carries a high thrombogenic index,

Content of Fatty acids in Common Cooking Mediums (Percentages per 100 g)

Oil/fat	MUFA	PUFA	SAFA
Sunflower oil	19	69	12
Safflower oil	14	75	6
Mustard oil	59	21	12
Groundnut oil	46	32	17
Sesame oil	40	42	14
Soybean oil	24	61	14
Cottonseed oil	18	52	26
Corn oil	28	59	13
Olive oil	74	8	14
Palm oil	40	10	50
Coconut oil	6	2	92
Butter	28	3	69

meaning thereby, that its users are at increased risk of blood clots, coronary attacks and stroke. Hard fats like *vanaspati ghee*, hard margarine, and lard are no better.

Reuse of vegetable oils

The next time that you pour vegetable oil in a frying pan, remember to use just enough oil and if there is any left after the cooking is done, just discard it. This safety measure is necessary because fats are altered by high temperatures and turn into toxic compounds. The result is worse if the oil is used repeatedly. Vegetable oils become rancid as a result of this, picking up highly reactive oxygen that can damage the cellular components. They also polymerise, forming new harmful compounds such as peroxides, benzene and free radicals. Hydrogenation of polyunsaturated fatty acids converts them into saturated fats, making them as hazardous as *vanaspati ghee*, lard and hard margarine. They are known to raise the levels of total and LDL cholesterol and increase the rate of fat deposition in the arterial walls.

Repeated heating of foods prepared in vegetable oils can be equally hazardous. The best course therefore is to roast, steam, grill, and bake instead of deep-frying the food.

Jamun, fenugreek seeds and blood sugar

Jamun and fenugreek seeds have long been used as traditional cures for diabetes. There sugar-lowering utility effect has now also been validated by biochemists. Researchers have isolated an active principle, alpha glucosidase inhibitor, from the *jamun* fruit. This places *jamun* in close company with the alpha glucosidase inhibitor medication, acarbose. Both avert the blood sugar from rising too high following a meal.

Fenugreek (*methi*) seeds also exert a blood sugar lowering effect. They also lower the cholesterol and triglycerides. The beneficial effects of fenugreek seeds relate to their high fibre content and trigonelline, an alkaloid, to which they owe their sugar-lowering result. A daily intake of 25-50 gram fenugreek seeds divided equally and taken with morning supper and dinner (approximately two teaspoons with each meal) can be most useful for a diabetic person. The seeds can be taken after overnight soaking with water or in powder form as a drink in water or buttermilk fifteen minutes before the meal. The powder can also be mixed with flour, rice, dhal or vegetables.

An expectant mother's diet

A well-balanced nutritious diet is the key to a healthier pregnancy. The belief that an expectant mother must eat for two is erroneous. The high-fat, high calorie Indian flour recipe of *panjeeri*, and *ladoos* studded with dry fruits, is certainly passé. It is best to eat moderately. High-calorie foods lead to overweight and obesity, and the extra weight gained are always hard to shed later.

Additional Allowance During Pregnancy*

Food item	How Much Extra Food You Need	Calories
Cereals	35 gram	118
Legumes	15 gram	52
Milk	100 gram	83
Fat	No extra allowance	—
Sugar	10 gram	40
Total	293	

**Source:* *Indian Council of Medical Research*

A pregnant lady needs 300 extra calories a day. She can find these extra calories in 100 ml of milk, a piece of cheese, *dhal,* meat, fish and eggs, and fresh fruits and green leafy vegetables. Taking extra rations of folic acid right from the first month also makes sense. It reduces the risk of neural tube birth defects in the baby.

What a nursing mother must eat?

A nursing mother must eat a well-balanced diet. It need not be elaborate. Simple *dhal*, *roti* and *sabji*, and cheese, grilled meat, or fish, and plenty of fresh fruit make a good choice. During the first six months, a nursing mother needs 550 extra calories a day to feed the baby. This allowance drops to 400 calories, once the baby is put through the process of weaning. Feeding the baby also increases the demand on water, and the mother should drink fluids in plenty. ■

Additional Allowance During Lactation**

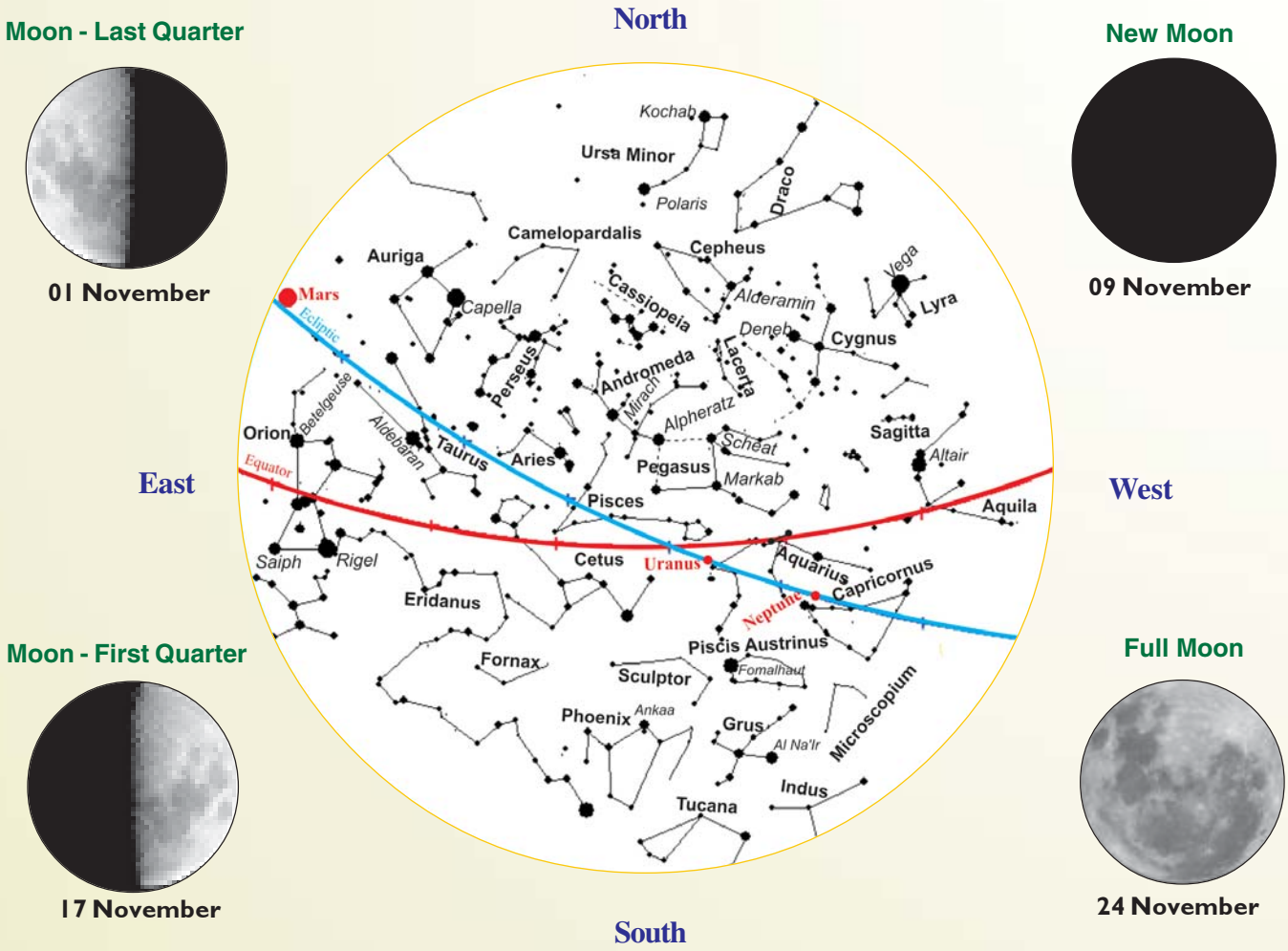
Food item	How Much Extra Food You Need	Calories
Cereals	60 gram	203
Legumes	30 gram	105
Milk	100 gram	83
Fat	10 gram	90
Sugar	10 gram	40
Total		521

***Source:* *Indian Council of Medical Research*

Dear Readers, We had incorporated a questionnaire alongwith a self-addressed envelop in the September 2007 issue of "Dream-2047" for getting your comments about its contents and how it can be further improved to meet your needs. In case you have not sent back the questionnaire with your comments, please do so at the earliest. You do not have to pay postal charges if you use the self addressed envelope. The questionnaire is also available in our website www.vigyanprasar.gov.in. You may enter your comments on-line.

— Editor

Sky Map for November 2007



The sky map is prepared for viewers in Nagpur (21.09^0 N, 79.09^0 E). It includes bright constellations and planets. For viewers south of Nagpur, constellations of the southern sky will appear higher up in the sky, and those of the northern sky will appear nearer the northern horizon. Similarly, for viewers north of Nagpur, constellations of northern sky will appear higher up in the sky, and those of the southern sky will appear nearer the southern horizon. The map can be used at 10 PM on 01 November, at 9:00 PM on 15 November and at 8 PM on 30 November.

Tips for watching the night sky :

(1) Choose a place away from city lights/street lights (2) Hold the sky-map overhead with 'North' in the direction of Polaris (3) Use a pencil torch for reading the sky map (4) Try to identify constellations as shown in the map one by one.

Planet/Dwarf Planet Round Up:

Mars: In the constellation Gemini (*Meethun Rashi*) near eastern horizon.

Uranus: In the constellation Aquarius (*Kumbha Rashi*) up in the zenith sky*.

Neptune: In the constellation Capricorns (*Makar Rashi*) up in the south-western sky*.

(* Are not naked sky objects.)

Prominent Constellations: Given below are prominent constellations with brightest star therein (in the parenthesis). Also given are their Indian names.

Eastern Sky : Auriga (Capella), Orion (Betelgeuse, Rigel, Saiph), Taurus (Aldebaran) / *Vrishabh Rashi.*

Western Sky : Aquila (Altair), Aquarius / *Kumbha Rashi*, Capricorns / *Makar Rashi,* Cygnus (Deneb), Lyra (Vega), Sagitta.

Southern Sky : Eridanus, Fornax, Grus, Indus, Microscopium, Phoenix, Piscis Austrinus (Fomalhaut), Sculptor, Tucana.

Northern Sky : Camelopardalis, Cassiopeia / *Sharmishtha*, Cepheus (Alderamin) / *Vrishaparv,* Draco, Ursa Minor (Polaris) / *Dhurva Matsya* (*Dhurva Tara*).

Zenith : Andromeda / *Devayani,* Aries / *Mesha Rashi,* Cetus (Deneb Kaitos), Lacerta, Pegasus, Perseus, Pisces / *Meen Rashi.*

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Astronomy

Earthquake Tip-17
How do Earthquakes Affect Reinforced Concrete Building?

Reinforced Concrete Buildings

In recent times, *reinforced concrete* buildings have become common in India, particularly in towns and cities. Reinforced concrete (or simply *RC*) consists of two primary materials, namely *concrete* with *reinforcing steel bars*. Concrete is made of sand, crushed stone (called aggregates) and cement, all mixed with pre-determined amount of water. Concrete can be molded into any desired shape, and steel bars can be bent into many shapes. Thus, structures of complex shapes are possible with RC.

A typical RC building is made of horizontal members (beams and slabs) and vertical members (columns and walls), and supported by foundations that rest on ground. The system comprising of RC columns and connecting beams is called a 'RC Frame'. The RC frame participates in resisting the earthquake forces. Earthquake shaking generates inertia forces in the building, which are proportional to the building mass. Since most of the building mass is present at floor levels, earthquake-induced inertia forces primarily develop at the floor levels. These forces travel downwards - through slab and beams to columns and walls, and then to the foundations from where they are dispersed to the ground. As inertia forces accumulate downwards from the top of the building, the columns and walls at lower storeys experience higher earthquake-induced forces (Figure 1) and are therefore designed to be stronger than those in storeys above.

Figure 1: Total horizontal earthquake force in a building increases downwards along its height.

Roles of Floor Slabs and Masonry Walls

Floor slabs are horizontal plate-like elements, which facilitate functional use of buildings. Usually, beams and slabs at one storey level are cast together. In residential multi-storey buildings, thickness of slabs is only about 110-150mm. When beams bend in the vertical direction during earthquakes, these thin slabs bend along with them (Figure 2a). And, when beams move with columns in the horizontal direction, the slab usually forces the beams to move together with it. In most buildings, the geometric distortion of the slab is negligible in the horizontal plane; this behaviour is known as the 'rigid diaphragm action' (Figure 2b). Structural engineers must consider this during design.

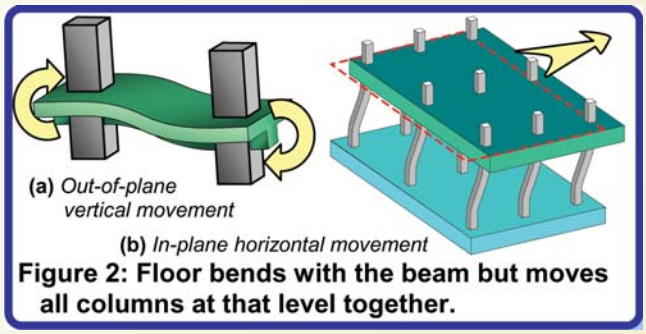

Figure 2: Floor bends with the beam but moves all columns at that level together.

After columns and floors in a RC building are cast and the concrete hardens, vertical spaces between columns and floors are usually filled-in with masonry walls to demarcate a floor area into functional spaces (rooms). Normally, these masonry walls, also called infill walls, are not connected to surrounding RC columns and beams. When columns receive horizontal forces at floor levels, they try to move in the horizontal direction, but masonry walls tend to resist this movement. Due to their heavy weight and thickness, these walls attract rather large horizontal forces (Figure 3). However, since masonry is a brittle material, these walls develop cracks once their ability to carry horizontal load is exceeded. Thus, infill walls act like sacrificial fuses in buildings; they develop cracks under severe ground shaking but help share the load of the beams and columns until cracking. Earthquake performance of infill walls is enhanced by mortars of good strength, making proper masonry courses, and proper packing of gaps between RC frame and masonry infill walls. However, an infill wall that is unduly tall or long in comparison to its thickness can fall 'out-of-plane' (*i.e.,* along its thin direction), which can be life threatening. Also, placing infills irregularly in the building causes ill effects like 'short-column effect' and 'torsion' (these will be discussed in subsequent *IITK-BMTPC Earthquake Tips*).

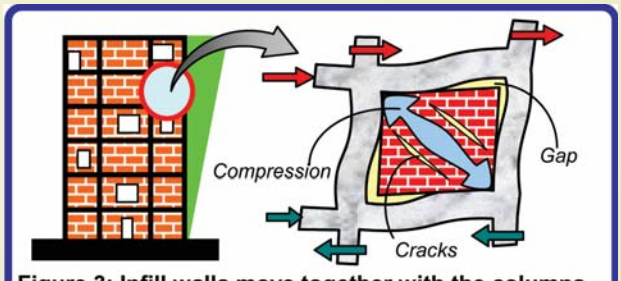

Figure 3: Infill walls move together with the columns under earthquake shaking.

Horizontal Earthquake Effects are Different

'Gravity loading' (due to self weight and contents) on buildings causes RC frames to bend resulting in stretching and shortening at various locations. Tension is generated at surfaces that stretch and compression at those that shorten (Figure 4b). Under gravity loads, tension in the beams is at the bottom surface of the beam in the central location and is at the top surface at the ends. On the other hand, 'earthquake loading' causes tension on beam and column faces at locations different from those under gravity loading (Figure 4c); the relative levels of this tension (in technical terms, 'bending moment') generated in members are shown in Figure 4d. The level of bending moment due to earthquake loading depends on severity of shaking and can exceed that due to gravity loading. Thus, under strong earthquake shaking, the beam ends can develop tension on either of the top and bottom faces. Since concrete cannot carry this tension, steel bars are required on both faces of beams to resist reversals of bending moment. Similarly, steel bars are required on all faces of columns too.

Strength Hierarchy

For a building to remain safe during earthquake shaking, columns (which receive forces from beams) should be stronger than beams, and foundations (which receive forces from columns) should be stronger than columns. Further, connections between beams and columns, and columns and foundations should not fail so that beams can safely transfer forces to columns and columns to foundations.

When this strategy is adopted in design, damage is likely to occur first in beams (Figure 5a). When beams are detailed properly to have large ductility, the building as a whole can deform by large amounts despite progressive damage caused due to consequent yielding of beams. In contrast, if columns are made weaker, they suffer severe local damage, at the top and bottom of a particular storey (Figure 5b). This localized damage can lead to collapse of a building, although columns at storeys above remain almost undamaged.

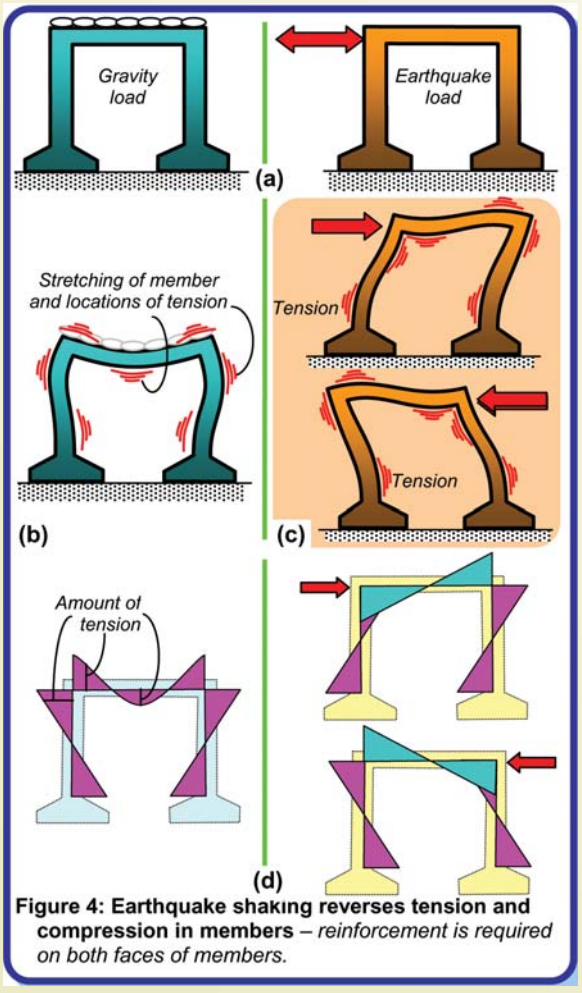

Figure 4: Earthquake shaking reverses tension and compression in members – *reinforcement is required on both faces of members.*

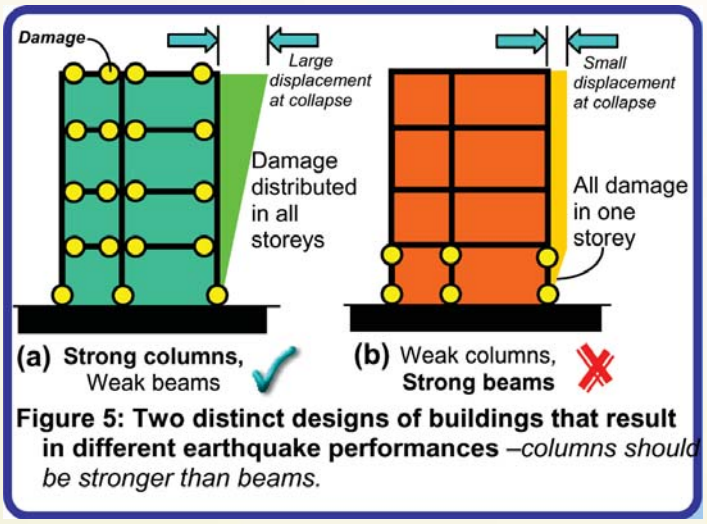

Figure 5: Two distinct designs of buildings that result in different earthquake performances –*columns should be stronger than beams.*

Relevant Indian Standards

The Bureau of Indian Standards, New Delhi, published the following Indian standards pertaining to design of RC frame buildings: (a) Indian Seismic Code (IS 1893 (Part 1), 2002) – for calculating earthquake forces, (b) Indian Concrete Code (IS 456, 2000) – for design of RC members, and (c) Ductile Detailing Code for RC Structures (IS 13920, 1993) – for detailing requirements in seismic regions.

Related IITK-BMTPC Earthquake Tip

Tip 5: What are the seismic effects on structures?

Resource Material

1. Englekirk,R.E., *Seismic Design of Reinforced and Precast Concrete Buildings*, John Wiley & Sons, Inc., USA, 2003.
2. Penelis,G.G., and Kappos,A.J., *Earthquake Resistant Concrete Structures*, E&FN SPON, UK, 1997.

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Recent Developments in Science and Technology

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Could Earth survive a red-giant Sun?

Our Sun is an average-size star that will end up as a red giant in about 5,000 million years from now as it runs out of hydrogen fuel in the core. As it reaches the red giant stage the Sun will swell over a thousand times its current volume and then shrink back into a white dwarf. It was long believed by astronomers that as the Sun expands it would gobble up Mercury, Venus, and our planet, which would meet a fiery death. But a recent discovery suggests that the Earth's fate may not be as grim. An international team of astronomers has spotted a planet in a distant solar system that appears to have survived its star's red-giant phase, even though its original orbit would have been similar to Earth's (*Nature*, 13 September 2007).

The researchers, Roberto Silvotti from the Astronomical Observatory of Capodimonte in Naples, Italy and colleagues from Europe, the US, Israel, and Taiwan, analysed the movements of V 391 Pegasi, a star that ceased to be a red giant some 100 million years ago. In its current form V 391 Pegasi, which is classified as a subdwarf B star, pulsates as it fuses helium into carbon in its core. After monitoring the star for over seven years Silvotti and colleagues noted a wobble in the star's motion repeating every 3.2 years, indicating the presence of a low-mass companion with this orbit period. With 97% certainty, they calculated this companion to be a large planet roughly 10,000 million years old – the first known to orbit a post-red-giant star. The study thus suggests that planets orbiting close to a star – within twice the distance from the Sun to Earth, or 2 AU – can survive the red-giant phase (1 AU = 150,000,000 km).

The current of orbit of the planet of V 391 Pegasi lies at a distance of 1.7 AU, but the researchers estimate that before the red-giant phase when the star had more mass the orbit would have been closer, probably around 1 AU. Likewise, Earth's orbit is expected to increase from 1 AU to roughly 1.5 AU when the Sun eventually sheds mass while turning into a red giant.

However, despite the similarities, the discovery does not necessarily mean that Earth will avoid assimilation like the planet orbiting V 391 Pegasi. According to the researchers, it may be the first of many discoveries that will enable astrophysicists to more accurately forecast Earth's fate.

Source of dinosaur-killing asteroid traced

Ever since two Berkeley scientists, the father and son duo Louis and Walter Alvarez proposed that a giant asteroid or comet striking the Earth some 65 million years ago caused the massive die-off and drove all the dinosaurs to extinction, there have been several attempts at locating the place of such an impact. After languishing for many years, the Alvarez theory gained strong support from the discovery in the 1990s of the remains of the huge (177 km in diameter) Chicxulub crater in the Yucatan Peninsula in Central America that dated to 65 million years ago. But where did the asteroid come from? Now the answer seems to be at hand. A team of planetary scientists now report that they have identified the specific space object that killed off the dinosaurs and half of all the other species on Earth at that time (*Nature,* 6 September 2007). According to the scientists, it was one huge asteroid that broke up in a violent collision 160 million years ago, sending a massive fragment careering out of the asteroid belt and eventually into the Earth's crust. The impact kicked up a storm of dust, cold and darkness that shrouded the Earth, cutting off sunlight for months that eventually led to the extinctions.

The giant asteroid Baptistina breaking up after collision

In the *Nature* paper, the group headed by William F. Bottke, an asteroid expert at the Southwest Research Institute in Boulder, Colorado, USA, traces that impact back to a giant asteroid named Baptistina nearly 160 km in diameter. According to the scientists, Baptistina was rammed by another, unnamed asteroid at least 55 km in diameter in a violent collision about 160 million years ago. The collision showered nearby space with at least 300 fragments bigger than 30 km in diameter and more than 140,000 smaller asteroids, each one more than 2 km around. According to Bottke and his colleagues it was one of those 'refugees' from Baptistina that created the 177-km-wide Chicxulub crater. Not only that, they say, it was another earlier Baptistina offshoot asteroid that crashed into the Moon about 110 million years ago and gouged out the well-known lunar crater called Tycho.

What caused the dinosaur-killer to fly out of the asteroid belt and smash into Earth? According to the researchers, the killer asteroid may have been driven out of its orbit between Mars and Jupiter by a kind of gravity 'resonance' that sent those crater-forming asteroids into the Earth-Moon system.

H_2S can limit heart attack damage

The biggest risk with a heart attack is that once damaged, heart tissue cannot recover and extensive tissue damage can be fatal following a heart attack. So the best alternative is to prevent the tissue damage as far as possible. A team of US medical scientists have reported that administering hydrogen sulphide, or H_2S, directly into the heart during a heart attack significantly reduces tissue and cell damage (*Proceeding of the National Academy of Sciences*, 18 September 2007). According to the researchers, H_2S boosts post-heart-attack function by helping minimize what is known as 'ischemia-reperfusion injury' – an unwanted side effect of restoring blood flow swiftly to hearts suffering from low oxygen.

It has been known earlier that H_2S is an endogenously produced gaseous second messenger capable of modulating many physiological processes including vasodilation (dilation of blood vessels), much like nitric oxide. Although long considered a noxious gas with wide-ranging toxic effects on cells, there is now an accumulation of scientific evidence that H_2S plays a prominent role in cellular signalling. These properties of H_2S prompted the research team to investigate the potential of H_2S as a protective agent for the heart.

The team carried out the tests on mice and found that the H_2S injection led to a 72 percent reduction in the amount of severe heart-tissue death after restoring normal oxygen and blood flow to mice hearts. The average amount of tissue death in untreated mice hearts after the same 30 minutes of oxygen deprivation was much larger. According to the researchers, this observed protective action is associated with an inhibition of inflammation of the heart muscle and a preservation of both mitochondrial structure and function after I-R injury. These findings on the protective qualities of H_2S have broad implications for improving human survival after cardiac arrest, heart transplant and trauma in general.

OBITUARY

Dr A P Mitra
(21.2.1927 - 3.9.2007)

The eminent radio physicist and atmospheric scientist, and former Director General of the Council of Scientific and Industrial Research (CSIR), Dr A.P. Mitra, FRS, passed away on 3 September 2007 in New Delhi. He was 81. A scientist with unshakeable commitment to science, Dr Mitra was actively engaged in research and was associated with several international scientific bodies till his last day. At the time of his death he was Scientist of Eminence at the National Physical Laboratory (NPL) in New Delhi of which he was Director during 1982-86. As Director General of CSIR he brought about sweeping changes in the CSIR system, paving the way for inducting outside talent that have paid rich dividends in later years.

Ashesh Prosad Mitra was born in Calcutta (now Kolkata), West Bengal, on 21 February 1927. He graduated from Presidency College and completed his D.Phil. from the University of Calcutta in 1955. He worked under Prof. S.K.Mitra, FRS, who is remembered for his pioneering work in ionospheric and related atmospheric research.

Dr Mitra did most of his research in the field of Earth's near-space environment, through ground-based and space techniques. He initiated new experimental techniques for monitoring of the troposphere and ionosphere, and developed an ionospheic prediction system that has played a crucial role in planning broadcasting and point-to-point communication systems in India over the past three decades. His pioneering work on cosmic radio noise for studying the upper atmosphere led to new discoveries in ionosphere, solar physics and cosmic ray physics.

During the past couple of decades, Dr Mitra's work mostly concerned global environmental changes brought about by human activities and their consequent impacts on the biosphere. He played a key role in formulating the Indian response to climate change. He was internationally known for his contributions to the ozone hole problem, to measurement of greenhouse gas emissions in India, and to global environmental chemistry.

Dr Mitra was actively associated with the Indian programme of the International Geophysical Year 1957-58, International Quiet Sun Year 1964-1965, and the International Geosphere-Biosphere Program in the 1990s. In a unique honour to Indian science, Dr Mitra was chosen to lead investigating teams of several international global change related programmes.

Dr. Mitra was a Fellow of the Royal Society, London; Fellow of Indian National Science Academy; Fellow of Third World Academy of Sciences; and Fellow of the International Academy of Astronautics. He was President of the International Union of Radio Science (URSI) during 1984-87 – the first Indian and second Asian to hold this high office. He was a member of the General Committee of International Council of Scientific Union (ICSU) during 1984-88.

Dr Mitra's contribution to science brought him several awards and honours, including the Shanti Swarup Bhatnagar Award for Physical Sciences (1968), Sir K. S. Krishnan Memorial Lectureship of INSA (1975), C. V. Raman Award of UGC (1982), FICCI Award for Physical Sciences (1982), Om Prakash Bhasin Award for Physical Sciences (1987), Modi Science Award (1992), Meghnad Saha Medal of the Asiatic Society (1994), and S.K. Mitra Centenary Medal of Indian Science Congress Association (1995). Government of India honoured him with Padma Bhushan in 1989 for his services to the country.

☐Biman Basu

Science Writing in Hindi: A Symposium

Vigyan Prasar has been organising many activities and seminars during the Hindi Fortnight observed by the Government of India every year. This year too on 20 September 2007 a symposium was organised in New Delhi on the theme "Scientific Writings in Hindi" in which senior litterateurs, journalists, scientists and science writers participated. Initiating discussions Dr Vinay B. Kamble, Director, Vigyan Prasar expressed his concern on the unavailability of good popular science material in Hindi perticularly in the emerging areas. He also said that most of the available material on science was found only in English. He exhorted all present to find out ways and means to overcome this deficiency. He requested the experts to suggest constructive measures to deal with the situation.

In his welcome address Dr Subodh Mahanti, Scientist 'F' and Chairman, Vigyan Prasar Rajbhasha Samiti said that such assemblies have had been organised earlier also, but this is the first occasion when litterateurs, journalists, editors, scientists and science writers have shared the same stage. Dr Mahanti felt the need of a regular forum for the betterment of Hindi science writing and said that this programme is a right step in that direction which will strengthen the cause.

In the first session of the symposium Dr Ramesh Dutt Sharma, well known science writer termed the organisers of the programme as crusaders and expressed his concern on the failure of Hindi not picking up in the sphere of scientific literature. He desired that the Hindi scientific dictionary should be made simpler so that common people are able to understand the terminology. In the same session Sh. Prempal Sharma, Joint Secretary, Railway Board, desired to have a campaign to inculcate scientific temper in the country. He suggested that all books on science published by any institution in the country be put at one place to facilitate dissemination of science books and publications in Hindi Next speaker, Dr. Yatish Agarwal, Safdarjung Hospital, New Delhi, said science writing should be kept away from misleading statistics as was witnessed recently in the case of details presented by media or the prevalence of Hepatitis B. In the same session Dr. Manoj Patairya, NCSTC, DST, requested the writers to maintain a balance between simplicity and technicalities in their creations. Continuing the discussions Smt. Kshama Sharma, Editor, *Nandan*, raised the question of evolving scientific temper and spread its importance. She said science writing in Hindi continues to be in chaste Hindi, which is not understood by common people. Shri Subhash Lakhera, DIPAS, New Delhi, in his intervention mentioned that science news should never be twisted by writers which, sometimes, kills the essence of the subject and disillusions the reader.

In the next session Shri Sanjeev, Executive Editor, *Hans*, talked about spreading science in the interiors of the country in the local languages. He appealed to carry the science news to local tribal groups and organisations which have now became very active. Shri Pankaj Bisht, well-known hindi writer, expressed his concern on unavailability of books on medical science in Hindi which is a big handicap for the students who are not very fluent in English. The intelligentsia should raise this issue for a positive outcome. Shri Manglesh Dabral, Senior Journalist, drew the attention of the participants on poor science coverage in Hindi media in comparison with English media. Speaking on the subject 'science and faith', Dr. Harikrishna Devsare, well-known science writer, said faith and science should complement and not confront each other. He added that famous scientist, Albert Einstein, was also a religious person. He advised that science and science writings should be in consonance with social and national ethos.

In the third session Dr. Pradeep Kumar Mukherjee, Dept. of Physics, Desh Bandhu College, New Delhi, opined that no compromises can be made with the fundamental theories of science. Awareness should be spread about necessities such as, importance of potable water and how bacteria and virus are different from each other. Smt. Madhu Pant wanted interesting write-ups to quench the inquisitive minds of children. Smt. R. Anuradha, Editor, Publications Division, drew the attention of the audience to the importance being given to science news coming from abroad and neglect of such news being published by local newspapers. Shri Devender Mewari, resident editor, Vigyan Prakash, spoke about popularising science by disseminating information through drama, poetry, street plays and other such activities. Shri R.K. Anthwal, Editor, *Avishkar*, invited young generation to read and write in Hindi on science subjects which offers plenty of opportunities for career growth. Shri M.R. Mahapatra, Editor, NBT, invited science writers to stimulate scientific temper among the young generation. Shri Birender Kumar Tyagi, from Vigyan Prasar said that Hindi science writing can be popularised by use of radio and drama. Dr. Anurag Sharma of Vigyan Prasar, talked of providing more opportunities to young writers for developing Hindi science writings. Shri Nimish Kapoor of Vigyan Prasar, wanted better placement opportunities for the journalists passing out of science journalism courses to ensure that newspapers and television channels do not carry unscientific and misleading information. ■

Vigyan Prasar celebrated Hindi Fortnight 2007 during 14-28 September 2007. A symposium on *Hindi me vigyan lekhan* was organised on 20 September 2007 on the occasion in which senior litterateurs, journalists, scientists and science writers participated. Hindi writing and Hindi extempore speaking competitions were also organised during Hindi Fortnight in which VP members took part with zeal.

Letters to the Editor

Thought-provoking Editorial

It was by a lucky accident that I found your issue for this month (September). Your editorial in it – 'Rivers at risk' – is immensely readable, captivating and thought-provoking. It brings into sharp focus our brutality towards our rivers and their delicate ecosystems. I will frankly admit here that until I read your editorial, I used to think that dams were a useful necessity. You have suggested some measures but we have come so far that I doubt whether we will be able to turn the hands of time back. Still, if we want to give our rivers a renewed life, the government, local bodies and we; the common people must act together and act fast before it is too late. Another article I enjoyed reading was 'Yogic exercises and diabetes'. You are doing a great job. Please keep it up.

— Pratap Rajeshirke
Shirgaon, Maharashtra, 416610