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# VP News

## Mercury Transit

Mercury transit is a rare phenomenon that takes place only 13 to 14 times in a century. During the transit, the planet Mercury comes in between the Earth and the Sun, and when viewed through a telescope with a proper filter, a black dot appears to move across the face of the Sun. On May 07, 2003, Mercury transit took place – the first transit of the 21st Century. This was an occasion to spread awareness about the celestial phenomena among the school children and the general public alike. Vigyan Prasar organized an awareness programme on Mercury transit at Technology Bhavan, New Delhi, on this day. Arrangements were made for viewing this rare phenomenon live through a telescope with the image of the Sun projected onto a screen from a telescope. On-line demonstration was organized both at the Raman Auditorium at Technology Bhavan and on the Vigyan Prasar Website *www.vigyanprasar.com*. The images were continuously grabbed by a Net Cam and transferred to the Vigyan Prasar Home Page. The website recorded nearly 3,000 hits for viewing the phenomenon live which lasted for about 5 hours from 1045 hrs to 1602 hrs. Vigyan Prasar homepage had already provided detailed information on different aspects of Mercury and Mercury transit. The live web cast of the Mercury transit was organized by Shri V. Krishnamoorthy assisted by Shri Bhaskar Karnick, Shri Jatin Bhai and Shri Hari Om. Dr. V.B. Kamble , Acting Director, VP gave a lecture - demonstration to make people familiar with different aspects of the transit phenomena. Incidentally, transits of Venus are extremely rare – there was no transit of Venus seen in the 20th Century. The next transits of Venus will be seen from the entire country on June 08, 2004. In addition, Venus transits take place in pairs separated by 8 years with more than a century separating each pair. Dr. Kamble stated that the Mercury transit of this year would indeed be a dry run for the bigger event next year – transit of Venus.

*Hon'ble Minister Prof. Murli Manohar Joshi taking a look at the Mercury transit. Also seen Dr. V.B. Kamble, Acting Director, Vigyan Prasar*

*Prof. V.S. Ramamurthy viewing the Mercury transit in the premises of Technology Bhavan. Smt. Ramamurthy is also seen*

Incidentally, Dr. Murli Manohar Joshi, Hon'ble Minister (Science & Technology, Human Resource Development and Ocean Development) had a view of the Mercury transit through the Questar telescope of Vigyan Prasar. Professor V.S. Ramamurthy and Smt. Ramamurthy also witnessed the live transit of Mercury at Technology Bhavan. Vigyan Prasar in collaboration with Government and non-Government organizations, plans to organize a nationwide programme on S&T popularization built around the transit of Venus on 08 June, 2004.

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# Inside



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

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# A Hard Way to Software

Not long ago, the term software only meant computer software. Now it includes all forms of audiovisual programmes – say, audio (including radio), video, films, slide shows, printed matter, and of course computer software including CD-ROMs and multimedia. The term has almost become a part of daily life – more so, if one happens to be a media person or a science communicator. When we talk of media – any media – we invariably talk of software and the quality of software. Embark upon a mass awareness campaign, development of an activity module for schools, a radio or a television serial, and the greatest challenge before the organizers and producers is to produce quality programmes - or software, which is relevant, interesting, meaningful and acceptable by the end users. Indeed it is a great challenge. If the software to be produced is for Science & Technology (S&T) communication, the challenge is even greater.

Several agencies in the country today are engaged in producing software for S&T communication. All India Radio broadcasts at least one programme everyday on a scientific topic from all its stations, in addition to the ones on health and agriculture. Several AIR stations with science cells broadcast three programmes per day. Doordarshan telecasts about two programmes every week on the national network, and all regional centres put together produce and telecast some 100 S&T programmes every year. UGC, CIET, and IGNOU have regular slots on Doordarshan. IGNOU even has its own network for FM radio and television with a twenty-four hour satellite TV channel. A few other Government / non-Government agencies too have hired regular slots on radio and television channels. However, with a population of a billion plus, eighteen major languages, varied needs of different geographical regions, and diversity of cultures, this is less than a drop in the ocean! How do we go about it then?

Given that the social and economic progress of a country depends on the application of S&T, it is imperative that due emphasis be given to dissemination of information on current issues / topics, and communicating to the people how closely their lives are entwined with S&T and scientific outlook. With growth of Information Technology coupled with significant increase in literacy and spread of education, expectations of the people also have gone up. To accelerate the process of development, Indian Space Research Organisation (ISRO) is planning to launch a satellite - Edusat - exclusively for education in which a channel would be dedicated to S&T. As a result, Edusat would indeed stand for Education, Science and Technology. Of late, Development Educational and Communication Unit (DECU) of ISRO has been organizing brain-storming workshops in different parts of the country to assess the needs of the people, the type of software to be produced for different target groups - or content development as it also called, and the ways and means to produce a large number of good quality programmes to continuously feed the science channel. More often than not, the discussions during these meetings centre on the production of "good" software. Normally there is consensus that despite we have wherewithal, technology, resources, and creative producers, what we still lack is the content. Why is it so?

The science channel for Edusat will require a variety of programmes to be developed for various sections of the society and age groups. In particular, at school level, the content for formal education may include topics in curriculum or enrichment material. The content development for the non-formal stream of science education is a much more daunting task. It may include topics like model rocketry, origami, astronomy, water, environmental issues, cropping patterns and so on. These topics could be simultaneously dealt with even for out-of-school students studying through alternative systems like National Open School or Sarva Shiksha Abhiyan. Even if some agency is not directly involved in production of S&T video programmes, it can still contribute to the production, say, in development of scripts, or can provide subject experts. A large number of resource persons for S&T popularization have come to the fore in last couple of decades. They could form a large pool of highly accomplished resource persons / experts for content development.

Surely, we have adequate infrastructure in the country with facilities like TV studios, labs and workshops for R&D and production of software for S&T communication. Despite the fact that we have a number of AVRCs, EMRCs, SIETs and DDKs, how is it that the number of producers of "good" software on S&T is minuscule? A majority of producers today are not conversant with the techniques and requirements of production of software on S&T. No doubt, this issue would need to be resolved at the earliest. There is no gainsaying the fact that we need to embark upon a programme to "produce" good producers of software on S&T.

Once the topics / issues are decided upon through workshops at regional and national levels, the next step would be to invite the subject experts to develop the contents and prepare briefs / write-ups on individual topics. The briefs / write-ups could be given to the producers depending on their aptitude. The producer may modify the script to meet the specific demands to suit the production maintaining the accuracy of scientific information in the script. The demands for interactive programmes, say two way audio and one way video are quite specific and also require special skills on the part of the producer. It also needs a good deal of coordination with the studios where the talk back facility is provided. This being a relatively a new area, special attention would need to be provided for the purpose. Transmission with Edusat being digital, selected programmes / software could also be made available on CD-ROMs and disseminated to the schools.

Finally, it is important to realize that the format in which the software is to be produced depends on the content. It is the content that decides the format of a programme to be produced – say, dramatization, questions–answers, quickies, and so on. Further, it is imperative that information be combined with entertainment. This demands a good understanding of the subject matter on part of the producer, creativity and imagination. In addition, every programme to be produced should aim at triggering an interest in science alongwith inculcation of scientific attitude. Is it demanding too much? Perhaps yes. But, we do not have much of a choice but to attain the high professional standards combined with creativity and imagination if we hope to transform our country into a nation of scientifically thinking people. Otherwise, we shall always be playing the second fiddle. Indeed, it is a hard way to good software.

❑ **V.B. Kamble**

**Editor : V.B. Kamble**

*Address for correspondence* : *Vigyan Prasar*
: *C-24, Qutab Institutional Area, New Delhi-110 016*
: *Tel: 26967532; Fax: 26965986*
*e-mail : vigyan@hub.nic.in*
*website : http://www.vigyanprasar.com*

# Louis Pasteur

## A Great Benefactor of Humanity

❒ Subodh Mahanti

"I was born to a tanner. He was a worker but was always eager to learn. He was my first teacher and it was he who inspired in me the love for work, as a direction for my work, instilled in me the love for my country. May your work also be governed by these two passions."

*Louis Pasteur*

Where does genius come from? Often, we are contented with attributing it to a unique, exceptional and mysterious resource of mind. On the contrary, in the case of Pasteur, we see clearly that the power of his genius comes from multiple sources, very much in opposition to his intelligence, character and temperament. He was an artist and a dreamer. He would allow himself to be fascinated by mirages of an imagination which always tended to go beyond the horizons of knowledge. He was ambitious and dominating and would be satisfief only with real and complete victories. He was rigorous and demanding towards himself. At the same time he would spare no efforts to be severe and disciplined.

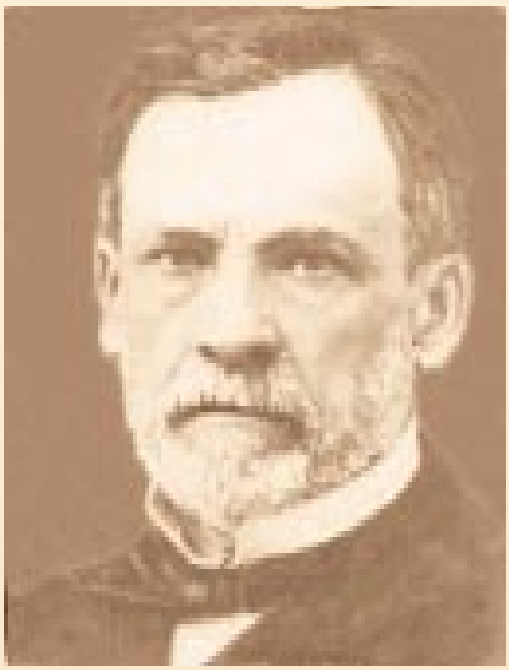
*Jacques Monod while speaking on the occasion of the celebration of the 150 birth anniversary of Lois Pasteur in 1973.*

"Pasteur has done much more than create the science of microbes : he inaugurated the era of scientific medicine … Pasteur opened medicines to science : he introduced into the medical body the notion of germ – non-microbial – which brought in a permanent revolution. Preserver in all fields other than science, preserver by nature with great respect for order, traditions and institutions, Pasteur - "who was not even a doctor" – was to force open the doors of the sacrosanct temple of medicine, to clear the fog of scholastic learning and destroy the existing idols; doctors where going through scientific training, doctrines ceased to be frozen into dogmas, the prevailing mentalities and attitudes were transformed.

*Claire Salomon-Bayet*

Louis Pasteur is regarded as one of the greatest biologists of all times. Isaac Asimov, the prolific science writer, said : "In biology it is doubtful that any one but Aristotle and Darwin can be mentioned in the same breath with him."

Pasteur solved the mysteries of rabies, anthrax, chicken cholera, and silkworm diseases and contributed to the development of the first vaccines. Pasteur was responsible for some of the most important theoretical concepts and practical applications of modern science. Although not a physician, Pasteur was undoubtedly the most important medical scientist working in the 19th century. He gave a new meaning to medicine. He was one of the forerunners in the study of microorganisms. He not only explained the causes for contagious diseases but also recommended ways of avoiding them. Pasteur was a founder of the germ theory. He laid the foundations of three distinct sciences- Immunology, microbiology and stereochemistry. It was Pasteur who brought to an end the debate on spontaneous generations which had continued for centuries. He clearly demonstrated that spontaneous generation was not possible. And doing so Pasteur set the stage for modern biology and biochemistrty. Psteur described the scientific basis for fermentation—the process of production of wine, beer and vinegar. He clearly demonstrated that the nature of fermentation was organic (a product of a certain type of living organism) and not inorganic, as proposed and defended by Justus von Liebig. Pasteur developed a vaccine against anthrax, a particularly deadly, highly communicable disease of domestic animals.



Louis Pasteur

The name of Louis Pasteur became a household word for his two inventions: pasteurization process for sterilizing dairy foods and a vaccine for rabies. While these two inventions are hallmarks of his long, rich career but he achieved much more. In public mind the name of Pasteur is associated with rabies to such an extent – that his main discoveries are often forgotten.

Science was the main passion of his life and his whole life was devoted to it. Pasteur said; "Science…it is my life…it has brought me a deepness of pleasure that I have always known yet never realized." Pasteur was a great hero in his own times and he remains so to this day.

Pasteur was born on 27 December 1822 in Ole in France and grew up in the nearby town of Arbois. His father Jean Pasteur was a tanner without much education. Pasteur

was very much influenced by his father. In one of his letters to his father Pasteur wrote: "You (Pasteur's father) might not remember how important your influence on me was in developing my mind… It was you who helped me decide to study natural sciences—undoubtedly because of your own interest in the subject rather than your conviction regarding my aptitude. Enthusiasm and mother's presence of mind were all passed on to me by you. If I have always associated the grandeur of our country it is because of the feelings that you inspired in me."

*Crypt in the Institute where Pasteur rests in peace*

In his early school days Pasteur was not an outstanding student. The young Pasteur preferred fishing and painting to studies. He showed great talent for drawing. He made a series of portraits of his family members, classmates and neighbours. Several of his portraits are exhibited at the Pasteur Museum. On his portraits Pasteur wrote to his parents: "Some students told me that people in Besancon were talking about a schoolboy who draws his classmates. The fact is, as I already told you, my first portrait was exhibited in the reception area where people come to see students. However, all this is not going to fetch me a seat in Ecole Normale. I would prefer a first place in the college to the ten thousand praises that are loosely showered in general conversations." Though Pasteur could easily become a superior portrait artist but fortunately for science he did not pursue this career. Pasteur himself became interested in scientific subjects particularly in chemistry. Pasteur's father was not in favour of his son ending up as an artist. He wanted that his son after completing his education become a professor in the college at Arbois. However, the headmaster the local school recognized Pasteur's potential and convinced his father to send young Pasteur to Ecole Normale Superiuere in Paris, the most prestigious university founded specifically to train outstanding students, for careers in higher education in science and humanities. On 26 August 1842 Pasteur qualified for admission to the Ecole Normale and among the twenty-two candidates selected Pasteur ranked fifteenth. His physics was classed as "passable"' and chemistry "mediocre". Not satisfied with the result Pasteur decided to appear for the entrance examination the next year again. In the second attempt he was ranked 4th. As a part of his preparation for his second attempt Pasteur attended Dumas's lectures on chemistry . He developed a special fascination for chemistry and all his future work showed a chemical approach, even to biological problems. Pasteur was deeply attached to Ecole Normale. In the notes furnished by Pasteur in 1895 for the publication brought out on the occasion of the centenary of the Ecole Normale Pasteur wrote: ""when I was a student of the College in Arbois, the words Ecole Normale would light up my soul…The surroundings were so dark and gloomy; the only source of light in dingy hall was from the north; the laboratories would not satisfy a single school today; yet, it was here that many ideas flourished; there was a passion for work which, even after fifty years here, draws me into its frenzy…Do you realize that the authors of these notes has always been fondly attached to the Ecole Normale? It is here that he met some great scientists and hundreds of very fine people, found wonderful friends and had the joy of seeing students become teachers."

*Discovery of molecular dissymetry, based on a study on crystals, had wide-ranging applications*

It was at Normale Ecole that Pasteur carried out most of his investigations. Emile Roux while commenting on Pasteur's working style wrote: "In order to be closer to the work place, both the master and his pupils stayed at the Ecole Normale itself. Pasteur used to come first always….As soon as he entered, he would get down to work with a cardboard piece and a pencil in hand. He would observe the cultures and go down to the basement to see animals being experimented upon. Then, we used to do autopsies, showing, microscopic examinations, etc. You must see Pasteur at his microscope in order to have an idea of the patience with which he examined the preparation. Moreover, he observed everything with the same degree of care: nothing escaped his eye (even though he was short sighted!) and we used to joke that he used to see microbes grow in the broth. Later,

Pasteur wrote down whatever observed…"

Over the course of 50 years – the second half of the 19th century – Pasteur's discoveries revolutionized chemistry, agriculture, industry, medicine, surgery and hygiene. These discoveries greatly improved the human

*Pasteur's work on fermentation and wines (1863)*

condition.

Pasteur was a chemist. He launched his memorable scientific career by studying the shapes of crystals of tartaric acid, an organic acid. He wanted to know why tartaric and paratartaric or racemic acids, which had the same chemical composition exhibited different optical properties in solution. Pasteur had observed that tartrate (salt of tartaric acid) synthesized in laboratory was optically inactive that it was unable to rotate the plane of polarized light but tartrate from grapes could easily rotate a beam of polarized light to the right. He was convinced that the internal structures of the two compounds must be different and this difference would show in their crystal forms. Upon careful examination under a microscope Pasteur found that crystals of tartaric acid looked alike. They possessed an identical asymmetry – which could rotate a beam of polarised light to the right. However, when Pasteur examined the crystals of the paratartic acid he found that there were two types of crystals. Both the types were asymmetrical. But one type was mirror image of the other, in the same way as the right hand mirrors the left.. Pasteur then performed a simple and elegant experiment, perhaps the most simplest and yet the most elegant in the annals of chemistry. Pasteur first separated the two types of crystals in two piles. For separation he only needed a dissection needle and a microscope. After the separation he could then demonstrate that in solution one form rotated the light to the right and the other form to the left. Based on this experiment Pasteur suggested that the optical property shown by a molecule is the result of the internal arrangement of atoms in space. The experiment was the beginning of a new science, which we call stereochemistry—the branch of chemistry dealing with the arrangement of atoms or groups of atoms that make up molecules. Pasteur's simple experiment demonstrated that organic molecules with the same chemical composition can exist in space in unique stereospecific forms. Pasteur did not stop at proposing that different optical properties in solution is the result of the difference in structure in space. He went a step ahead. He proposed that asymmetrical molecules were indicative of living processes. In other words, living organisms only produce molecules that are of one specific orientation and which are always optically active. The proteins in higher animals are made up of only left-handed amino acids and not their mirror images or the right hand forms. Our body cells only burn the right-handed form of sugar to produce energy and not the left-handed form.

In 1854 Pasteur joined the Faculty of Sciences in Lille as Dean and Professor of Chemistry. It is here that his attention was drawn to the problem of alcoholic fermentation. Lille was an industrial town with a number of distilleries and factories. One distiller named M. Bigot, father of one of Pasteur's students in chemistry, sought Pasteur's help in overcoming his difficulties in manufacturing alcohol by fermentation. This was in summer of 1856. Bigot's problem was that often his fermentation yielded lactic acid instead of alcohol. At the time it was believed that the

*Through his studies on silkworms, Pasteur saved the silk industry and paved the way for research on infectius diseases*

process of fermentation leading to production of wine, beer and vinegar was a straightforward chemical breakdown of sugar to the desired molecules.

At Bigot's factory the following observations of Pasteur led him to solve the puzzle of alcoholic fermentation:

i) The yeast cells found in the fermenting vats of wine remained healthy as long as normal production of alcohol continued but when lactic acid formed the yeast cells were found to be mixed with rod-like microbes. It may be noted here that before Pasteur explained the fermentation process scientists believed that yeasts were simply to be either a product of fermentation or catalytic agent that helped the fermentation proceed smoothly.

ii) Alongwith alcohol (that is ethyl alcohol) other complex organic compounds were found to ber produced during the fermentation. This could not be explained by the simple catalytic breakdown of sugar shown by Lavoisier. There must be other additional processes involved.

*The Pasteur Institute (1888)*

iii) Some of the organic compounds produced during the fermentation were found to be asymmetric that is they rotated plane of polarized light. Pasteur believed that living cells only produced asymmetric molecules.

Based on the above observations Pasteur concluded that the fermentation process was carried out by living cells, the yeasts. The fermentation turned sour when the yeast was contaminated with other microorganisms. In this way Pasteur won the battle against Justus von Liebig, who believed that fermentation was a purely a chemical reaction involving non-living oraganisms.

To prevent the fermentation from going sour Pasteur suggested that while the yeast, the organism which produced fermentation, should be allowed to work but not other microorganisms. To achieve this Pasteur suggested to heat the wine slightly to kill the contaminated organism after the fermantation was complete and to close the container. This process of killing undesirasble microorganisms is now called pasteurization. Pasteur's findings not only transformed the vinegar, the wine and the beer industry but also changed the bread, milk and cheese industry. Pasteur described his conclusion in the following way: "…I arrived at the conclusion that all diseases concerning wine, at least those that are known presently are determined by microscopic plants which are like ferments. In this way, one can say that when wine is bottled, the germ leading to its disease is also sealed inside. In order to preserve wine, it became necessary to find a way killing such germs. I first tried adding chemical substances which gave me some interesting results. But, they did not satisfy me for several reasons. Finally, I tried the effect of heat and I think I arrived at a very practical processs. All that needs to be done is to keep the wine temperature ranging between 60 to 100 $^{0}$C, in closed containers, for an hour or two."

Pasteur's research on fermentation created great excitement and controversy. His experiments were criticized by those who believed in the theory of spontaneous generation, a subject speculated from Greek ans Roman times, was still debated in the exalted French Academy of Sciences. This made Pasteur to turn his attention to the question of where microorganisms came from. To Pasteur, it became obvious, that yeasts and other microorganisms found during fermentation and putrefaction came from the outside. He pointed out that dust of the air was the carrier of contamination.

In 1865 Pasteur was asked to investigate a new disease devastating the silkworms of Southern France. Before taking up the work of investigating the disease, Pasteur knew nothing of silkworms. In fact in his own words, 'he had never even seen a silkworm.' A considerable confusion was caused by the presence of two quite independent infectionsss. Pebrine, in which black spots and corpuscles were generally, but not always, present on the worm. The worms affected by this disease often died within the cocoons. In the second type of the disease, flacherine, the worms exhibited no corpuscles or spots but failed to spin cocoons. During investigating the silk-worm disease Pasteur suffered a stroke which partially paralysed his left side. However, Pasteur managed to complete his experiments, analysis and conclusions of the problems plaguing the development of heralthy silkworms. He provided a comprehensive analysis of the disease and its promotion. Pasteur suspected that pebrine corpuscles were responsible for the failure of the worms. By examining the

*Two men fighting with a rabid god. Miniature from the Bagdad school (1224)*

silkworms under the microscope Pasteur was able to identify those free of pebrine and he used only their eggs for breeding. He also excluded from breeding eggs from worms with flacherine, whom he identified by their sluggish behaviour in climbing leaves when about to construct cocoon. Silk-worm farmers were instructed and Pasteur's methods of selection and how to use the microscope to detect sickness in the worms. In this way the silk industry in France returned to health.

On Pasteur's work on silk worms Emile Roux wrote: "There are many lessons pertaining to human medicine in this study on disease affecting silkworms!….Without knowing anything about all these doctrines, a chemist, who knew how to use a microscope for experiments, showed that everything boils down to a parasite transmitted by the sick to healthy subjects and by parents to their descendants. The mystery of the contagion is explained in this way…"

In 1880, Pasteur found the cause for boils and Osteomyelitis, a microbe in the form of a "mass of grains" (staphylococcus). He also discovered a microbe in perpetual infection in the form of a "rosary" (streptococcus).

Anthrax, a fatal disease of sheep and cattle, was destroying the sheep industry and economy of France. Robert Koch isolated the anthrax bacillus, which was earlier identified by the French physician Davain, from infected spleens. Koch also showed that under resting conditions the bacillus formed long-lived spores. However, it was not known whether the cultured bacillus, itself, and not something carried along in Koch's culture medium caused anthrax in the animals, in which the culture was injected. It was Pasteur, who conclusively proved that it was the anthrax bacillus which was responsible for the disease.

The most celebrated of Pateur's researches was the development of a vaccine against rabies, also called hydrophobia. Rabies has been known since times immemorial. Democritus is supposed to have been the first to describe rabies, five centuries before Christ. Pliny the Elder in the Book VII of his voluminous 'Natural History' wrote of "the worm on a dog's tongue which was thought to be the cause for rabies". Even during Pasteur's time rabies was a serious problem in France. The most obvious cause was of course the rabid dog. Many superstitions were associated with the treatment of rabies. The disease had been looked upon with horror. The treatments applied to victims were horrible, for example, cauterizing the bite wounds with a red-hot iron.

In December 1886 Pasteur decided to study rabies. It was not simple. There were no reliable models as well as a methodology which can ensure and renew the transmission of the disease between animals in order to study the disease better. The symptoms of the disease are varitable and it may take weeks to months to develop if they develop at all. In spite of these difficulties Pasteur decided to work on it as he realized that conquest of rabies would be regarded as a great achievement to the world of science and to the public at a large. Pasteur was not alone. A number of scientists in different parts of the world were interested in this disease. After Pasteur entered the field the contagious nature of rabies had been established. This had resulted the beginning of quarantines for dogs coming from a foreign country. Such preventive meausers controlled "local" rabies considerably. But then there was no proven treatment to save people bitten by rabid animals. Pasteur started his research by taking a sample of a saliva of a child who died of rabies and he used it to inoculate rabbits. In less than five years after his research began, he came out with a method to "manufacture" anti-rabies vaccine and a protocol for the vaccination. Initially he demonstrated the efficacy of his vaccine in rabbits and dogs. In 1885 Pasteur used a rabies vaccine developed by him on a badly bitten nine-year old boy, Joseph Meister. Against the advice of his colleagues Pasteur began the course of 14 injection using virus attenuated in the spine of rabbits. Meister survived and he become part of the history of medicine. Joseph Meister later became a caretaker at Pasteur's Institute.

*Pasteur taking a saliva sample from a rabid dog*

While presenting the results of his rabies treatment to the Academy of sciences on March 1, 1886 Pasteur called for the creation a rabies vaccine center. Pasteur said : "The cure for rabies resulting from dog bites was well founded. There was the need to create a vaccination for rabies." The Academ of sciences launched an extensive, international public drive for funding the proposed center and it was able to collect 2,586,680 Frances. With the overwhelming response shown by a number of people it was possible to acquire 11,000 $m^2$ of land on rue Durot. The Institute which bears the name of Pasteur was inaugurated on 14 November 1888 in the presence of French president Sadi Carnot. In his inaugural speech on the occasion Pasteur said: "…It can be said of the immense building which was constructed that, without exception, each stone stands as a material symbol for generosity. All virtues were combined to raise this work structure…My dear colleagues, maintain the

enthusiasm that you showed right from the beginning. At the same time, be extremely strict in monitoring. Do not forward anything that cannot be proved in a simple and decisive manner. Adopt a critical mind. By itself, it cannot encourage ideas nor stimulate anything great. But without it, everything is useless. It always has the last word. When I ask of you in this respect and what you will in turn ask of your disciples in the most difficult part for an inventor…" It may be noted that Pasteur became so emotional that he had to ask his son to read out his speech.

In accordance with Pasteur's wishes the institute was founded as a clinic far rabies treatment, a research center for infection disease and a teaching center. It became one of the premier international biological research. The 1891, the first Pasteur Institute was founded in Saigon (later rebamed Hochiminh City) in Vietnam launching but was to become a vast international network of Pasteur Institute. The Institute become so popular both in France and Abroad that it become a symbol of the country.

Pasteur was a great patriot but at the same time he realised the international character of science. He said: "I feel that I am harbouring two deep impressions : the first is that science does not have any nation; the second, which seems to be independent of the first, but is still a direct consequence of it, is that science is the highest personification of the nation, as amongst all the peoples, those who march ahead with their thought and inteleligence always lead."

Pasteur work is not simply the sum of his discoveries. It also represented the revolution of scientific methodology. Pasteur superimposed two indispensable rules of modern research, the freedom of creative imagination necessarily subjected to rigorous experimentation. He would teach his disciples. "…It is an art to propose conclusive experiments without leaving anything to the imagination of the observer. In the beginning any experimental research on a specific subject, imagination should give wings to the thought. At the time of concluding and interpreting the fats that were collected observation, the imagination should be dominated and prevailed over by concrete results of experiments." In fact Pasteur brought in a revolution, the pasteurian revolution, in science. And when Pasteur died it was not just the world of science and health that were no longer the same, the world itself became so different."

Pasteur possessed the most important qualities of a true scientist. He had the ability to survey all the known facts about a particular problem and link them for all possible hypotheses; he had the necessary patience and drive to carry out experiments under the strictly controlled conditions and above all the brilliance to draw the correct conclusion from the experimental results. While explaining the importance of experimentation Psteur said: "imagination should give wings to our thoughts but we always need decisive experimental proof, and when the moment comes to draw conclusions and interpret the gathered observations, imagination must be checked and documented by the factual results of the experiment." Further Pasteur said: "Preconceived ideas are the beacons which light up the path of experimenter and guide him in probing into nature. They become a danger only when they are transformed into fixed ideas. This is the reason why I wanted to see the following words inscribed at the entrance of any temple of science: "the greatest mischief of the mind is to believe certain things, as by believing we would want them to be so."

Louis Pasteur was a great humanist. He never filed any patents for his inventions. He could have easily amassed great wealth. His only ambition was to be useful. He emphasized the importance of research. Pasteur said: "I beseech you to take interest in these sacred domains called laboratories. Ask that there be more and that they be adorned for these are the temples of the future, wealth and well-being. It is here that humanity will learn to read progress and individual harmony in the works of nature, while humanity's own works are all too often those of barbarism, fanaticism and destruction." Pasteur was a great patriot. His feelings for his motherland are expressed in his following words: "Science was the main passion of my life. My whole life is devoted to it. In difficult moments, that cannot be separated from long hours of work, the thought of my motherland would encourage me. I used to associate her grandeur with the grandeur of scienc."

Pasteur died on 28 September 1895. The French Government honored Pasteur with a national funeral, which was held on 5 October 1895. His funeral was attended by thousands of people, who gathered in silence. People were seen crying out of emotion and gratitude. Louis Pasteur was initially cremated in the Cathedral of Notre Dame but it was transferred to a permanent crypt in the Pasteur Institute. The crypt was made of mosaic represents the principal periods of his work. In 1940 the invading Germans ordered Joseph Meister to open the crypt for inspection, but Meiser chose to kill himself rather than to so.

We would like to end this article by quoting what Francois Jacob said of Pasteur on the occasion of the centenary celebration of the Pasteur Institute: " … Pasteur left his mark, through his very style, not only on his students and Institute but on experimental biology as a whole. All the research activities of present day biologists tends to reformulate highly varied problems into issues that can be handled in the laboratory. Their efforts are geared towards finding answers through experiments. This trend in the field of modern medicine, and what we call public health today started with Pasteur and his strategy…."

## For Further Reading


1. *Louis Pasteur by Beverly Birch, Garth Stevens, Inc., Milwanke W1, 1989.*
2. *Pasteur and Modern Science by Rene Dubos, Doubleday and Co., Inc. New York, 1960.*
3. *Life of Pasteur by Vallery-Radot, Doubleday, Page and Co., New York, 1919*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# Operation Zero

❒ Rintu Nath

*Holi hai*!

I was celebrating *Holi* with my friends and relatives. It was colourful everywhere. The beautiful spectrums of colours of *gulal* made everything picturesque. It looked as if a little child played with his brushes quite liberally in his canvas.

My uncle was also in festive mood but he does not like all those colours. So he was just watching us from a distance and sometime cheering us up saying 'Attention Googol, someone is coming in this way!'

At one o'clock in the afternoon, I washed off the colours and had my bath. As I returned to drawing room, I found that my uncle was relaxing and watching television.

'So you had a nice time, Googol,' he said without taking his eyes off the television.

'Oh yes, it was very enjoying,' I replied and came near to him.

'But I did not play *Holi* with you! So I think that I can do it now,' he said, and suddenly rubbed something in my face.

'Uncle, I just had my bath and you …' I protested.

'Cool down, dear! Check yourself in the mirror, Googol, ' he said.

I realised that he had just put some talcum powder in my face.

'Don't you think that we should celebrate *Holi* with white colour only?' the question was directed at me.

'I could not get that,' I said.

'What physics say…,' he implied.

'Oh yes, white colour is the mixture of all colours,' I said and spread the powder over my face.

'Right, so the festival of colours will be really meaningful with white colour,' he added.

'I got that. That means if I put black colour in your face, actually I will not put any colour,' I quipped, 'you know, physics say that…'

'You naughty boy!' smiled uncle.

'So before putting forward your suggestion on real colourful *Holi*, we have to prepare being painted with *nothing* in our face from scientifically inclined persons,' I said.

'Well, I admit,' uncle said, 'but while dealing with *nothing* in mathematical world, you should be more cautious.'

'Yes, I remember, you earlier told me about the problems related with operation of zero. Could you please clarify more?' I was very eager to hear the next part of story and so I drew myself closer to him.

'Well, do you know about real numbers?' uncle asked.

'Real numbers consist all rational (i.e the numbers which can be express as $p/q$, like 2) and irrational numbers (which cannot be expressed as fraction, like $\sqrt{2}$),' I said.

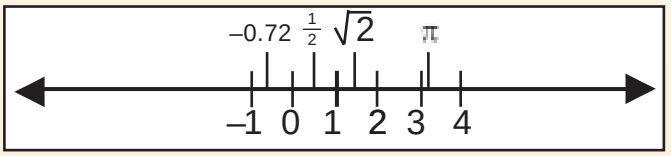
'Right. Now all these real numbers can be placed uniquely in a real line towards both positive and negative direction. Hence all positive, negative, even, odd, rational and irrational numbers correspond to only a single point on the line,' uncle explained.

I nodded my head understanding the real line principle.

'Could you now tell me, where zero stands in this real line?' uncle asked me.

'It seems that it is just standing as borderline between the positive and negative numbers,' I replied.

'Yes, among these real numbers, zero has the most important and unique position. It is in the intersection between positive and negative numbers. If you go to the right side from zero, it is positive numbers and if you go towards the left side of zero, it is all negative numbers. So essentially zero is neither positive nor negative number, it is the borderline for positive and negative numbers, or it is neutral in that sense. In fact this is the only number in the real number world, that is neither positive nor negative.'




'So zero is a lonely person standing in the borderline with nobody around it to share its characteristics – even 1 is not such a lonely number,' I joked.

'To be precise, zero as single entity has no power of its own. Even if you put the poor fellow to the left side of any number (without any decimal), still it is powerless. But if you start adding it to the right side of a number, then zero starts showing its power and the number increases by ten times for each addition.'

'So a lonely and tiny person can be real powerful depending on the situation. But does zero share any feature of an odd or even number?' I questioned.

'Well, simply speaking an even numbers are those which are divisible by 2 and odd numbers are those that are not divisible by 2. Since theoretically zero is divisible by 2, so zero is considered to be even number. But many people do not consider zero as even number since zero is divisible by any number irrespective of positive and negative and divisibility with 2 is not very unique feature to zero as that of other even numbers.'

'What about zero as prime number?' I got interest in the discussion.

'A prime number is a positive integer that has no positive integer divisors other than 1 and the number itself. So by definition, prime number is a positive integer and should be placed in the right hand side of 1 in our real line scale. Clearly zero does not fit in this definition and so zero is not a prime number.'

'I can understand now that Brahmagupta might have to give a lot of thinking to define zero in a number system and to present the rules for its operation. I can remember that he correctly defined the position of zero in the number system and gave the rules of addition, subtraction and multiplication.'

'You are absolutely right. If we add zero with a positive and negative number, then we will remain in the same number point in the real line scale. And if we multiply any positive and

negative real number with zero, then we will be directed straight to the position zero.'

'And what about the division by zero?' I asked.

'Well, the division by zero is a tricky one. Brahmagupta himself could not describe the operation properly and later Bhaskara also mentioned it incorrectly.'

'I can remember what Bhaskara said: if any number is divided by zero, it is infinity.'

'Well, at first instance, assigning some positive number divided by zero as infinity or very high value, seems logical. For example, if you continue to divide a real positive number by a smaller number, then your result will go on increasing. Like:

10/10 = 1
10/1 = 10
10/0.01 = 1000
10/0.0001 = 10,0000
:
:
$10/10^{-99}$ = $10^{100}$
and so on'

'So when we will divide the number by zero, it will go towards infinity or a very very high value,' I said.

'Well, as you divide by a smaller number and go towards zero, the result increases. But remember, still the smaller number is not equal to zero. Therefore, you are *not* actually doing any division by zero, rather you are predicting a trend, which might be possible if divisor reaches a value, closer to zero or very small numbers. But whatever the smallest number you can think of, another number smaller than that exists. Moreover, you should remember that infinity is a concept, an abstract thing, not a number as defined in our number system and all rules of mathematics are invalid while you will consider operation with infinity. Like if you add infinity and infinity you will not get twice the value of infinity. It is still infinity!'

'Then it is wrong to say that a number divided by zero is infinity,' I said.

'Exactly! In fact, in the very first place it is wrong to attempt to divide a number by zero,' uncle emphasized.

'So what should be the actual explanation for this situation?' I was curious.

'Well, let me give you a further clarification. A division is essentially the inverse of multiplication rule. That means if you divide 10 by 2, then you will get 5. And if you multiply 5 with 2, then you will get your original value back again. Through algebra, we can put it like this:

If ( $a$ / $b$ ) = $c$, then $a$ = ( $b$ * $c$ )

Let's see what will happen if we follow the infinity theory. Assume that $a$ = 10 and $b$ = 0. Now, if you attempt to do ($a$ / $b$) and assume $c$ = infinity, then according to rule of multiplication, we get 10 = (0 * infinity). But the rule of multiplication for zero says that anything multiplied with zero is zero. That means, applying the multiplication rule in right hand side gives us finally: 10 = 0. So you cannot get back 10 by multiplying the elements in the right hand side, rather you will get some absurd result as above while attempting and evaluating something divided by zero.'

'So we should not divide a number by zero…'

'Yes! The uniqueness of division breaks down when you attempt to divide any number by zero since you cannot recover the original number by the inverting the process of multiplication. And zero is the only number with this property and so division by zero is *undefined* for real numbers. So you should *never* attempt to do a division with zero. In fact, it is meaningless to attempt to do this operation.'

'Ok, I should not attempt to do any mathematical operation related with division by zero since it is not even defined in our mathematical world.'

'Let me give you another very common example to show what could happen if you ever try to attempt to do something like that.

Let, $x = y$

Multiplying both side by $y$, we get, $x * y = y * y$

If we subtract $y^2$ from both side, then it becomes: $x*y - y^2 = y*y - y^2$

**Undefined**

In mathematics, an expression is said to be **undefined** which does not have meaning and so that is not assigned an interpretation. For example, division by zero is **undefined** in the field of real numbers.

**Indeterminate**

A mathematical expression is said to be **indeterminate** if it is not definitively or precisely determined. Certain expressions of limits are termed as **indeterminate** in limit theorem. There are seven indeterminate forms involving 0, 1 and infinity (∞).

$(0 / 0)$, $0 . \infty$ , $(\infty / \infty)$, $(\infty - \infty)$, $0^0$, $\infty^0$, $1^\infty$

**Vanishing**

A function, which takes the value zero for a particular set of points, is said to **vanish** for that set of points. For example, in the function y = x2, the value of y will vanish in points where x = 0. Sometime the term, **vanish identically** is used in the same perspective to denote that the function takes the value which is mathematically identical and equal to zero.

**Non-vanishing**

A function, which takes the non-zero values for all sets of points, is said to **non-vanishing**. For example, in the function $y = (x^2 + 1)$, the value of y will be non-vanishing for real values of x.

**Identically Zero**

Sometime, to put it sufficiently strongly, a quantity that rigorously assumes the value of zero is said to be **identically zero**. A quantity that is identically zero is said to be **vanishing**, or sometimes to **vanish identically** as mentioned above.

**Zero free**

An integer value whose digits contain no zeros is said to be **zero free**. For example, square of 334 is a zero free square. In recent times a lot of interesting works are going on to find the **zero free** number for $n^{th}$ power.

**Absolute Zero**

**Absolute zero** is the temperature when there is no movement of molecules. The measurement of temperature cannot go lower than this and this is shown in Kelvin scale as zero. The **absolute zero** is equivalent to -273 degree Celsius.

This can be written as: $x*y - y^2 = y^2 - y^2$

With some simple algebra, the expression becomes: $y * (x - y) = (y + y) * (y - y)$

Since we have assumed, $x = y$, so we can write: $y (y - y) = (y + y) * (y - y)$

Now if we divide both side by $(y - y)$, then it comes as: $y = 2y$

Or if we cancel out $y$ from both sides, it is 1 = 2.

Ok Googol, tell me now why does this type of meaningless result come after doing all those seemingly legal algebraic operation?'

'I think that the cancelling out $(y - y)$ is not the correct method…'

'Right! You can see that we are actually cancelling out $(y - y)$ from both side, which actually equals to zero and legally we cannot do the simple division with zero and if you do, it will make thousands of mathematical rules invalid. Simply speaking, there is no number in real number world, which equals to the expression: *x divided by zero*.'

'Now I can understand, that is why the division by zero is made *undefined* in mathematical terminology so that if we follow this simple single rule then we don't have to worry about thousands of other mathematical rules which will be valid always.'

'Yes! This is the reason that in all computer programs or mathematical calculations, one should take care of this vital operation and there should have appropriate strategy to deal with this situation. Imagine, a remotely controlled rocket is going towards a distant star and the computer installed in it, is doing millions of vital calculation every second. But the scientists who programmed the computer just inadvertently forgot to tell the computer what it should do if something like division by zero occurs. And unfortunately if it occurs, the computer will stop working and it will wonder what to do with this undefined operation. So all the efforts of the scientists will be a waste! Zero is so powerful.'

'I have seen that if I try to do the division by zero in calculator it shows 'E'.'

'Right. This means the operation you are attempting is erroneous and you should not attempt this operation.'

'Ok, so something divided by zero is undefined and it is wrong to do any operation involving that. Is this rule only applicable to real numbers?'

'Well, this is true for the world of real numbers. But in calculus theorem, limits involving division by a real quantity, which approaches zero, may be well-defined. For example, you will get the expression like this: *limit x tends to zero* ( $\sin x / x$) equals to 1. But be careful, our concept of something divided by zero as undefined still holds good, since in above function you are *not* attempting any value of $x$ which is equal to zero. For the same reason limits like *limit x tends to zero* ( $1 / x$ ) do not exist.'

'When it is so critical phenomenon with something divided by zero, I wonder what about zero divided by zero?'

'Well, this is another interesting case. Mathematically speaking, an expression like zero divided by zero is called *indeterminate*. To put it simply, this is a sort of expression, which cannot be determined accurately. If you see the expression properly, you can't assign any value to it. That means (0 / 0) can be equal to 10, 100 or anything else and interestingly the rule of multiplication also holds true here since 10 or 100 multiplied by zero will give the product as zero. So the basic problem is that we cannot determine the exact or precise value for this expression. That's why mathematically (0 / 0) is said to be *indeterminate*.'

'It's amazing! It is now understandable that why our forefathers had the problem in defining operations involved with zero. They have done really a great job. I remember, Bhaskara has also given the correct rule for square of zero.'

'Yes. The square of zero is similar in meaning to multiplying zero two times. So according to multiplication rule, it should be zero. It is not only square, but cube and all powers of zero is zero.'

'And what about the square root of zero?'

'Similar to square or cube of zero, the square root, cube root, fourth root and so on all will be zero. You can easily get the logic if you think that the square root of zero should be such a number, which if multiplied twice should give you zero. Or in other way, square root is nothing but taking ½ as power and so all powers of zero are equal to zero.'

'And what will happen if I make zero as a power to some

### Mighty Naught

The power of zero is sequenced in the following expression. The number in each power indicates the number of zeros that should follow after 1. For example, $10^6$ means that 1 is followed by 6 zeros. The definition mentioned here is American system of counting. So start counting your zeros now:

| | |
|---|---|
| $10^2$ = | *Hundred* |
| $10^3$ = | *Thousand* |
| $10^6$ = | *Million* |
| $10^9$ = | *Billion* |
| $10^{12}$ = | *Trillion* |
| $10^{15}$ = | *Quadrillion* |
| $10^{18}$ = | *Quintillion* |
| $10^{21}$ = | *Sextillion* |
| $10^{24}$ = | *Septillion* |
| $10^{27}$ = | *Octillion* |
| $10^{30}$ = | *Nontillion* |
| $10^{33}$ = | *Decillion* |
| $10^{36}$ = | *Undecillion* |
| $10^{39}$ = | *Duodecillion* |
| $10^{42}$ = | *Tredecillion* |
| $10^{45}$ = | *Quattuordecillion* |
| $10^{48}$ = | *Quidecillion* |
| $10^{51}$ = | *Sexdecillion* |
| $10^{54}$ = | *Septendecillion* |
| $10^{57}$ = | *Octadecillion* |
| $10^{60}$ = | *Novemdecillion* |
| $10^{63}$ = | *Vigintillion* |

And *Googol* ($10^{100}$) and *Googolplex*($10^{Googol}$) have already been mentioned earlier (see March issue of *Dream 2047*).

***Source:***

To find more on operation with zero and topics involving zero, see the web at: http://ubmail.ubalt.edu/~harsham/zero/zero.htm.

number?'

'Well, if you put zero as power to any number, it is always one. This comes from the rules by which we deal with operations involved with powers. For example:

$x^2 = x * x$

$x^{-2} = 1 / x^2 = 1 / (x * x)$

Hence, $x^0$ can be written something like: $x^{2-2}$

Which we can separate as: $x^2 * x^{-2}$

This gives us: $x^2 / x^2$, which makes our result as 1.'

'What about zero to the power zero?'

'Mathematically, this situation is similar to zero divided by zero. Using limit theorem, it can be found that as *x and a tend to zero*, the function *ax* takes values between 0 and 1 inclusive. So zero to the power zero is also termed as *indeterminate*. But modern day mathematicians are giving many new theories and insights regarding proper explanation of zero to the power zero. Some mathematicians say that accepting $0^0 = 1$ allows some formulas to be expressed simply while some others point out that $0^0 = 0$ makes the life more easier. So this expression is not as naïve as it looks like!'

'Now I know about two indeterminate forms in mathematics. The first one is (0 / 0) and the second is $0^0$. Is there any other indeterminate form involving zero?'

'Well, to be precise there are seven indeterminate forms in mathematics involving 0, 1 and infinity.'

'I have recently did many permutations and combinations during World Cup matches. So I feel curious to know about the factorial zero.'

'The factorial of zero is equal to one. This is because the number of permutations you can do with zero elements is only one. This also can be proved mathematically. Remember here that the factorial of one is also one.'

'Uncle, frankly speaking I have discovered zero today in completely different perspective. Till now I used to think that zero is a tiny number and makes everything easy while it appears in calculations. But now I can understand that this tiny number zero could give mathematicians in the world so many troubles. Hence whenever it is operation with zero, it should always be handled with care and caution. Am I right?'

'Yes, you are absolutely right! Zero is tiny number, but you should never ignore its might. Imagine the world without zero. Not only mathematics, but all branches of sciences would have struggled for more clear definitions in their individual contexts, had zero not exist in our number system. Numbers from 2 to 9 are absent in binary system, and so are 8 and 9 in octal system. However, zero is everywhere and it is one of the significant discoveries of mankind. Thanks to the ingenuity of our forefathers.'

'I think that if any organization codes a task as *Operation Zero* then we can presume it may not be a simple task at all…'

'Yes, it should be really the most difficult task since mathematics presume that the task involve many undefined and indeterminate operations!'

'Uncle, I have an idea. To extend our analogy of numbers with colours, it seems more appropriate to assign zero as black colour. They are physically nothing, but both of them have tremendous impact while you see them with other colours or numbers.'

'That's a good analogy, Googol! Put your imagination in motion…'

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# Recent Development in Science and Technology

## Genetic sequence of SARS virus Reveled

The full DNA sequence of the coronavirus believed to cause SARS has been published by scientists in Canada, the worst-affected western country. The genetic sequence is vital to developing tests for the infection, and drugs and vaccines to treat it.

The breakthrough comes as the SARS outbreak continues to worsen. It has now killed so many people and infected over 3400 in many countries around the world. The situation remains very serious in China, where SARS originated, and Hong Kong.Now few cases is also found in India.

The full coronavirus sequence will allow the development of faster, more accurate tests for SARS, using specific viral DNA fragments to prime PCR reactions. Early sequencing by the Bernhard Nocht Institute in Hamburg, Germany, has already helped the German firm Artus to produce a test that goes on sale on Monday.

The sequence will also permit the synthesis of specific viral proteins. These could be used to induce antibodies in healthy people, which can then be used to treat SARS patients.

Ultimately, viral proteins will be the basis of a vaccine. There are also long-term hopes that a detailed understanding of the function of the viral proteins could lead to specific antiviral drugs.

The sequence was produced at the Genome Sciences Centre (GSC) at the British Columbia Cancer Agency in Vancouver. The lab usually studies genetic changes in cancer, but it switched to work 24 hours a day on SARS after virus taken from a case in Toronto was cultured.

*Source :New scientist,April 2003*

## Scientists Add New Member to Vitamin B Family

A new page may need to be added to the vitamin B family album. According to a report published today in the journal Nature, researchers have determined that the compound known as pyrroloquinoline quinone (PQQ) should be classified as a vitamin in the same class as vitamins B2 and B3.

Scientists first isolated PQQ from bacteria in 1979. The compound was also thought to be important to mammals, but its precise biochemical pathways remained unclear. In the new work, Takaoki Kasahara and Tadafumi Kato of the Institute of Physical and Chemical Research in Japan elucidate PQQ's role in degrading the amino acid lysine in mice. They found that PQQ generates an enzyme that is required for the reaction to occur. Animals that were deprived of PQQ grew more slowly than their well-fed counterparts did and had fragile skin and compromised immune systems, the researchers found. In addition, the PQQ-lacking mice did not reproduce as well as normal mice did. The authors conclude that PQQ "therefore qualifies as a newcomer to the B group of vitamins." The human body cannot produce most vitamins, but plenty of PQQ can be found in a balanced diet that includes vegetables or meat .

*Source:Nature, April 2003*

**Compiled by: Kapil Tripathi**

# Turmeric

❒ T.V. Venkateswaran

Highly prized by ancient Indians, Arabs and Indo-Europeans for its medicinal uses, modern research is beginning to confirm that the potent roles Turmeric plays as an anti-inflammatory, anticancer, antimutagenic and antioxidant remedy. Turmeric is considered sacred by the Hindus and is commonly used in their religious ceremonies. It is believed to give the energy of the "Divine Mother" and grant prosperity and is usually associated with auspices ceremonies and fertility rites. In India, the use of Turmeric for various purpose dates back to Vedic period, about 4000 years ago, wherein turmeric was not only a spice to garnish food but also had religious significance. Even today in many parts of India Turmeric is culturally associated with good omen. Not surprisingly, Turmeric is a very important spice in India, which produces nearly the whole world's crop and also uses 80% of it.

The exact origin of Turmeric plant (Curcuma domestica) is rather uncertain, yet it is held that it may indigenous to South East Asia. A related species, C. xanthorrhiza, grows on Jawa, where it is called temu lawak; in taste, it is equivalent to C. domestica indicating possible indeginity of the spices to South East Asia.

*Figure 1: Turmeric plant*

## Poor man's saffron

Known as the poor man's saffron, turmeric is an ancient spice whose use dates back to recorded history. Turmeric may be used in many different ways. While in India the dried turmeric powder is most preferred and often used, in South East Asia turmeric is preferred as fresh rhizome, which is grated and added to curry dish. In contrast In Indonesia and Western Sumatra fresh turmeric leaves are used as flavouring. In India, turmeric is still added to nearly every dish, be it meat or vegetables. Furthermore, it appears in rice dishes (pullao) and is part of all curry powders. Due to Indian influence, turmeric has also made its way to the cuisine of Ethiopia.

During the medieval period, the vibrant south Indian kingdom of Cholas sent its army to South East Asia, and as a consequence, Indian influence could be discerned from the use of turmeric for cult and sacred purposes. Yellow rice (nasi kuning) is popular on the Eastern islands of Indonesia; it derives its colour from fresh or dried turmeric. In Bali, where the tasty nasi kuning is prepared from rice, turmeric, coconut milk and aromatic leaves. It is considered a "cultic dish" and sacrificed to the Gods and cones of yellow rice are offered to the Gods in Bali's most important temple at Besakih, closely resembling the practice in south India, where yellow rice showered on the head is expected to usher prosperity and fertility. On Jawa, Indonesia's most populous island, nasi kuning is still held a somewhat sacred dish even after decades of Islamic influence.

Turmeric is not only important spice of India; it is also one of the most important colouring materials. The rhizomes yield the orange-red dye, which is much used to impart a yellow colour to cloth and in combination with indigo to yield bright green. Furthermore no dying mordant is necessary. Even now, in the age of artificial dyes, turmeric dye is still used in particular for religious uses. Turmeric colour also serves as a chemical indicator since it changes its colour on adding acids or alkalies. In fresh state, the rootstock has an aromatic and spicy fragrance, which by drying gives way to a more medicinal aroma. On storing, the smell rather quickly changes to earthy and unpleasant. Similarly, the colour of ground turmeric tends to fade if the spice is stored too long and or exposed to sunlight, though when fresh its staining capability may seem a nuisance.

Indeed, in many languages, the names of turmeric just mean "yellow root"; Tamil Manjal is synonymous to the Tamil word for 'yellow', so are Haldhi in Hindhi, Dutch geelwortel, German Gelbwurz. English turmeric derives from the (now obsolete) French terre-mérite (Latin terra merita, "meritorious earth"), probably because ground turmeric resembles mineral pigments (ocher). In most contemporary European languages, the name of turmeric is derived more or less directly from Latin curcuma.

## Main constituents

The yellow pigmented fraction, isolated from the rhizomes, contains the curcumins belonging to the dicinnamoyl- methane group. Curcumin, $C_{21}H_{20}O_6$ , is insoluble in water but soluble in ethanol and acetone. Turmeric oil, composed of terpene- hydrocarbon-derivatives and sesquiterpenic ketones has also been isolated. Turmeric usually contains an essential oil (max. 5%), which contains a variety of sesquiterpenes, many of which are specific for the species. Most important for the aroma are turmerone (max. 30%), ar-turmerone (25%) and zingiberene (25%).

Conjugated Diarylheptanoids (1,7-diaryl-hepta-1,6-diene-3,5-diones, e.g. curcumin) are responsible for the orange colour and probably also for the pungent taste (3 to 4%). The Jawanese species C. xanthorrhiza contains 6 to 11% essential oil, which is dominated by 1-cyclo-isoprenemyrcene (up to 85%); it furthermore contains a phenolic sesquiterpene missing from C. domestica, xanthorrizol, which makes up max. 20% of the essential oil.

## Turmeric plant

Botanically related to ginger, Turmeric or Curcuma longa consists of more than 100 species and over 30

varieties of a cylindrical tuber (rhizome) with orange-colored flesh. Turmeric plant (Curcuma longa) is a robust perennial with a short stem and tufted leaves. The plant grows 3-5 feet and has large oblong leaves. It bears funnel-shaped yellow flowers are found in dense spikes. Flowers in autumnal spikes 10 to 15 cm long. It is a tall herb with large root stocks and consists of rhizomes which are ovate, oblong or pyriform and often short-branched. The rhizomes, which yield the colorful condiment, are short and thick with blunt tubers. Rhizome may be 2 to 6 cm long and 1 to 1.7 cm thick. Leaves very large, in tufts upto 1.2 ft.

Figure 2: Rhizome of turmeric

Turmeric plant is extensively cultivated all over India. India is the principal supplier of turmeric to the world markets. The total acreage under turmeric in India has been estimated variously from 60,000 to 100,000 acres, and the production is nearly 100,000 tons of rhizomes per annum. The usual time for planting turmeric is just before the rains. Active rhizome development continues until the crop is ready for lifting at about seven to nine months, when the lower

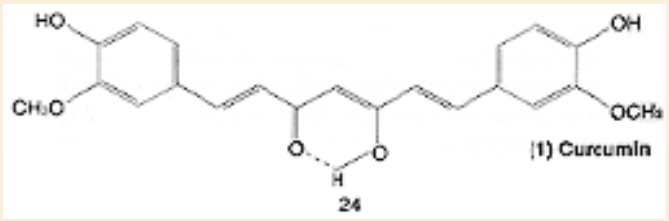


Figure 3: Chemical structure of Curcumin

leaves turn yellow. Circum aromatica is ready for harvesting in seven months, while Circum domestica is harvested in eight months. The intensity of its yellow-orange color and fragrant, earthy aroma depends on the plant's maturity at harvest, the more mature the better. After harvesting, the rhizomes are cured, dried, sliced and powdered for commercial use, mainly in curry powder and pickles.

## Uses of Haldi

Turmeric is invariably used in all systems of Indian medicine, be it Ayurveda, Siddha, Unnani or even traditional home remedies. Sweetened milk boiled with turmeric is a popular remedy for cold or sore throat. Also juice of the fresh rhizome or turmeric powder is applied to fresh wounds, bruises and leech-bites. In small-pox and chickenpox a coating of turmeric powder or thin paste is applied to facilitate the process of scabbing.

In traditional systems of medicine, turmeric is known as a stomachic, blood purifier, and is useful for common cold, leprosy, intermittent fevers, affections of the liver, dropsy, purulent ophthalmia (inflammation of the eye), otorrhea (discharge from ear), indolent ulcer, pyogenic (forming pus) affections, wound healing and inflammation. The rhizome of turmeric is highly aromatic and is considered antiseptic. Its paste is used in cleansing and disinfecting the skin and skin ulcer without drying out its natural oil. Turmeric powder significantly increases the mucus content in gastric juices, no wonder that Indian cuisine lays emphasis on turmeric's therapeutic effect against gastric disorders. Curcuma oil, curcumin and its alkali salts prevent histamine induced gastric ulceration. Undoubtedly, Turmeric is the most important medicinal plant of Indian traditional medicine system.

Although the chemical structure of this remarkable spice, food preservative and dye was identified in 1910, it was only in 1980s modern researches confirmed what traditional healers have known all along; that the fresh juice of the root reduces swelling in bruises, wounds and insect bites and the dried powder kills parasites, relieves head colds and arthritic aches and pains. Research is also beginning to show that turmeric may be a valuable anticancer agent. Experimental studies have shown turmeric to be as effective as cortisone, phenylbutane, and ibuprofen. Clinical tests have proved the bactericidal properties of turmeric. Curcumin and other curcuminoids inhibit growth of various bacteria like S. aureus, S. paratyphi, Trichophyton gypseum and Mycobacterium tuberculosis in concentrations varying from 1 in 20,000 to 1 in 640,000.

Curcuminoids present to the extent of 3 - 5 % in Tuermeric is an important active ingredient responsible for the biological activity of Curcuma longa. Though the major activity is anti inflammatory, it has also been reported to possess antioxidant, anti allergic, wound healing, anti spasmodic, anti bacterial, anti fungal and anti tumour activity. The essential oils show marked anti-microbial activity against gram negative (Vibrio cholerae, Salmonella typhi, Klebsiella aerogenes, B. coli) and gram-positive organisms (Corynebacterium diphtheriae, ß-hemolytic streptococci). The essential oil fractions from C. longa rhizomes of various habitats exhibit fungistatic (inhibiting the growth of a fungus) activity particularly against Aspergillus niger and Physalospora tucumanesis, Ceratocystis paradoxa, Sclerotium solfsii, curvularia lunata, Helminthosporium sacchari, Fusarium moniliforme and cephalosporium sacchari.

Figure 4: Turmeric root

Curcumin also inhibits intestinal gas formation by Clostridium perfringens at 0.05% concentration. Its effect was evaluated at 0.005, 0.013, 0.025 and 0.05% on gas formation by C. perfringen of intestinal origin. Gas formation decreased gradually as the curcumin concentration increased and there was no gas when curcumin concentration was 0.05%, the level at which bacterial growth was inhibited completely.

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# Central Glass and Ceramic Research Institute

❒ Manas Pratim Das*

"The Central Glass and Ceramic Research Institute deals essentially with one of the most important applications of science. It will, I hope, play an important role in developing not only the glass industry in India but many of its ramifications." Thus was expressed a fond hope of our first Prime Minister Pandit Jawaharlal Nehru on the occasion of the inauguration of a premier national laboratory designed to work at the frontiers of glass and ceramic technology.

The year was 1950 and the nation was witnessing great strides in development activities. Setting up of national research laboratories on the lines of those functioning successfully in the developed nations of Europe and USA was high on the agenda. Consequently a chain of such laboratories was set up. There was the National Physical Laboratory, which was inaugurated by the Prime Minister Nehru in January and the Fuel Research Institute was inaugurated by the President, Dr. Rajendra Prasad, in April. The auspicious day for the Central Glass and Ceramic Research Institute came on 26th August and this time it was Dr. Bidhan Chandra Roy, Chief Minister of West Bengal, who ignited the lamp.

It may not be irrelevant here to indulge in the history that led up to the setting of this great Institute, which today has become a great source of solution for the problems of glass and ceramic industry. In spite of the great demand for glass in British India, the state did not show any interest in strengthening the glass industry. The British rulers were happy in meeting their requirements through imports from Japan and Europe. Back home, the glass industry struggled and struggled without any assistance from the Government and reached the verge of ruin. On continued demand from the indigenous glass manufacturers, the Government did appoint a Tariff Board in 1931 but its recommendations were literally shelved. Things started to move in a positive direction with the coming into being of Board of Scientific and Industrial Research in 1940. Just a year later an editorial titled "Need Of a school of glass technology in India" in 'Science and Culture' observed:" If the glass industry in India has to be placed on a firm basis, it is of immediate importance that there should be a school of Glass Technology in a suitable centre which will arrange for adequate and effective provisions for training and research... " The editorial also noted that "The school should be so located that staff may be in active and frequent touch with the industry... The success of the British attempt is largely due to the location of the School at Sheffield, which was the centre of glass industry in England".

It may be remembered that Professor Meghnad Saha was then editor of 'Science and Culture'. This editorial was very effective in changing the mood of the Government. A subsequent report submitted by Prof. Saha and Sir S. S. Bhatnagar to the Board of Scientific and Industrial Research (BSIR) led to the appointment of a Central Glass Research Institute Committee in March,1942. The task of this committee was to advise the Board in this regard. A man of outstanding capabilities, Dr. Atma Ram was appointed secretary of this committee and entrusted with the job of fixing the site for setting up of the Central Glass and Silicate Research Institute (former name of this institute). After visiting Bombay, Benaras, Delhi and Jamshedpur he finally chose Calcutta as the site for the institute. His report was accepted and construction started on a twenty-bigha plot given by Jadavpur College of Engineering and Technology adjacent to its campus.

*Central Glass & Ceramic Research Institute, Kolkata*

Joining the institute as Officer-in Charge (later the first Director) Dr. Atma Ram had to cope with both financial and technological problems. To rope in the best ideas Dr. Ram visited Britain And America. In Britain he met Prof. W. E. S. Turner who was a pioneer in glass technology. The visits enriched him and helped the infrastructure-development of the institute. The culmination of the construction process came, as we have earlier learnt, on 26th August 1950. Prof. Meghnad Saha had observed on that occasion, "I hope that this institute will play as great a part in the development of the glass industry of this country as the Sheffield school of Glass Technology and the Kaiser Wilhelm Institute for silicate Research have played in the development of glass industries in England and Germany."

Dedicated to harnessing Science & Technological capabilities in the field of glass, ceramics, refractories and allied materials for strategic needs and also for the industrial and economic development of the country, the institute has been striving over the years to turn this hope into reality. Apart from the main centre in Jadavpur, Kolkata, the two extension centres of the Central Glass and Ceramic Research Institute (CGCRI) situated at Naroda (Gujarat)

and Khurja (UP) are also offering yeoman's service to the small and medium industries in the area of traditional ceramics.

Outlines of some recent research activities may help to highlight the contribution of the institute to the society.

### Optical Communication Fibre

Optical fibres, the backbone of global telecommunication network, have nearly infinite capacity to transmit information to a destination, hundreds of miles away, sometimes even without a repeater. CGCRI has generated the know how to fabricate single mode(SM) and Multi Mode (MM) fibres starting from the pre-form (diameters ranging from 15 to 30 nm and length up to 600 nm) stage to final fibre drawing. Special type optical fibres such as Erbium (Er) doped fibre for use as Optical Amplifier and Polarization Maintaining (PM) fibre for application in interferometric sensors, have been fabricated successfully. Of late, for fabrication of high quality doped silica fibres, ultra dry vapour delivery system and glass-working lathe have been added in preform making facility. In the pipeline is development of radiation sensitive optical fibre and other special purpose optical fibre for sensor application.

### Low Solubility Glass Fertilizer

CGCRI has developed unique chlorine and nitrogen free micro and major nutrient glass fertilizer to simulate soil flora. Low solubility glass fertilizer with no hygroscopicity is easy to store and use. Glass fertilizer is a brilliant realization of an idea of a harmonized nature management and represents a novel approach in this field. This not only solves economical and technical problems but also allows to protect rivers, lakes and ground water from pollution and thus to preserve them for next generations.

Micro nutrient glass fertilizer contains Iron, Sulphur, Potassium, Magnesium, Copper, Phosphorus, Cobalt and Manganese, which can be applied to soil in any season. The encouraging results have been obtained in Wheat,

**Interview with Dr. H. S. Maiti , Director, Central Glass and Ceramic Research Institute, Kolkata.**

**Q:** Sir, what are your future plans about this institute?

**Ans:** Central Glass and Ceramic Research institute is basically a material science and engineering laboratory. The scope of material science has widened in recent times. As for ceramics, at one time we were only concerned with traditional ceramics. Now, almost any inorganic material under the sun comes under the heading "ceramics". Smart materials, Nano materials are opening up new vistas in material science. These fields arc throwing up new challenges. We have to make our progress in these fields, keeping pace with the international scenario.

*Dr. H.S. Maiti*

Since the 1960s we are doing material science in the country but not doing enough to convert the scientific knowledge into viable technology and put it into market space. This Institute wants to bridge this gap. In fact, there is hardly any agency in the country to do this important job. Hence, we have to take up the responsibility.

Another thing is very important in this context. In the field of scientific research we should aim at new knowledge base as much of the existing knowledge base has lost its utility. Twant two separate team of scientists and engineers to focus on these two areas of concern i.e, adding engineering edge to existing knowledge base and preparing new knowledge base.

**Q:** What are the problems facing this institute?

**Ans:** The first and foremost problem is, of course, financial. Our R&D budget is very low and this needs to be increased. There is also problem with human resources. We are not getting enough motivated and dedicated research workers which is hampering our progress. This, I would say, is the greatest challenge. All R&D laboratories are facing this problem but we are perhaps facing it all the more. Glass and Ceramic There *is* has a small market and the students arc not quite aware of the opportunities and challenges in this field.

**Q:** What are the three major contributions of your institute in recent years?

**Ans:** The first major contribution is in the field of healthcare. Development of ceramic hip joint prosthesis and artificial eye for implant in human body are examples.

Second is the development of ceramic membrane technology which has found an excellent use in arsenic removal from drinking water in different arsenic polluted areas. I feel, in the coming years, this technology will also be productive in fields like biotechnology, food processing, petrochemicals etc.

Finally, there are optical fibres which is an area where Central Glass and Ceramic Research Institute has generated tremendous knowledge base in the last fifteen years.

**Interview taken by Manas Pratim Das.**

Sugarcane and Flowering plants.

Major nutrient SPK glass fertilizer contains Sulphur, Phosphorus and Potassium as major nutrients. Single application to the soil ensures effects lasting for one crop without any loss of efficiency. The significant results yielded from Mustard, Groundnut, Wheat, Chickpea and Pigeon pea.

CGCRI has standardized the technique and process parameter for manufacturing these novel glass fertilizers and studying its efficiency on other crops.

## Arsenic Removal by Ceramic membrane

This is a societal mission for *CGCRI.* Arsenic contamination in ground water has emerged as a serious health hazard issue in nine districts of West Bengal and Bangladesh as a whole. Hand pumps attached to arsenic removal units are primarily based on adsorption technique which produces treated water with arsenic content below 50 ppb as per BIS specification. In some cases the treated water has been observed to contain iron above the permissible limit.

*Section of optical glass plant*

With a view to eliminate the shortcomings of conventional techniques, CGCRI has developed a new technique using ceramic membrane filter suitable for treatment of highly contaminated water combined with enhanced separation efficiency in respect of both arsenic and iron content. The arsenic and iron content in water, filtered by CGCRI technique has been found to below the detection limit as recommended by WHO (less than 10 ppb arsenic and less than 0.1 ppm iron).

A pilot plant (60 litres/hour capacity) using multi-element ceramic techniques has been installed at Barasat, 24 Parganas (N) in West Bengal. The salient features of CGCRI process are complete removal of both arsenic and inon, generation of lower limit of sludge and modular design or enhancing the capacity from 2,500 to 10,000 litres per day.

## Waste to Wealth: Fly ash for Traditional Ceramics

Fly ash generated by thermal power plants possess a growing environmental hazard. Utilization of waste fly ash for making useful products is one of the approaches to solving the problem of its disposal. The potential of utilizing fly ash for making ceramic products is being explored by CGCRI in view of the possibilities for ready implementation in existing industries as well as initiating new enterprises.

Body compositions for unglazed/glazed semi vitreous ceramic tiles for applications in flooring facing and paving has been formulated using different proportions of fly ash as a replacement of quartz in the base compositions along with other required ingredients. The compositions were evaluated with respect to physico-chemical and thermo-mechanical properties.

Earthenware glazed wall tile body has also been developed utilizing fly ash. The quality has been appreciated widely.

## Break through in Bone Surgery

On May 9,1990 a 62 year old woman was implanted a ceramic Hip Joint Prosthesis for the first time in the country at Calcutta Medical Research Centre. Since then more than 50 patients have received such prosthesis and their medium-term follow up studies have shown encouraging results. The ceramic prosthesis, compose as alumina as femoral head and metal (316/ Ti-Al- V alloy) as stem has distinct advantage over all metal prosthesis in terms of longevity due to wear resistant and inertness of alumina ceramic.

A team of dedicated scientists of CGCRI ventured to take up this challenging R&D project with a mission to find ceramic parts for human body and ultimately came up with a product, which brought excitement not only to the scientists involved but also to doctors and patients when the journey from bench to bedside was completed.

## Ceramic Eye for Natural Eye

After the successful development of ceramic hip joint prosthesis. CGCRI scientists took up a more challenging task and this time their mission was to replace the damaged eye with a ceramic eye. The material which goes into making the artificial eye is calcium hydroxyapatite [HAP,Cal0(pO4)(OH)2], a major ingredient of natural bone and entirely different from alumina in properties. The ocular implant is made highly porous and conical in shape to facilitate the vascularisation. One of the postulated advantages of HAP implanter the glass or polymeric material is that, it becomes invested with fibro-vascular tissues of the orbit and provides natural movement to the eye which drastically improves the aesthetical appearance.

After a long experimentation in laboratory followed by animal trial, the product has been finally implanted for the first time in a young girl in the year 2001 at Eye Care Research Center, Kolkata. Till date, 18 patients have been implanted with CGCRI produced artificial eye and the post-operative results are very exciting.

## Pioneer in Coatings

In India, CGCRI has pioneered research in the area sol-gel science and emerged as a centre of repute. Anti-reflective and anti-glare coating on glass including radiation shielding windows, laser glass and ophthalmic lenses,

damage resistant coatings on laser glass surfaces, plasma-sprayable zirconia powders for coating of metals, silica glass, coatings on plastic have been developed.

Glass – ceramic coatings for the protection of metal surfaces against wear and tear, high temperature and chemical corrosion have been developed for industries such as the aeronautics, chemical, textile, thermal power plants etc. Coatings for nimonic-al1oy components of aeroengines are being used by Hal (Koraput) for several years now.

### Composites

Composites combining the advantages of the constituent materials have been prepared at CGCRI. The institute has produced glass-reinforced gypsum which work as a wood substitute. Another notable composite produced here is the lightweight jute-glass hybrid composite which has been successfully used for making engineering components like fans, railway tract junction box etc.

### Sensors for Safely alarms

*Trace Moisture analyzer:* Detection of gaseous moisture in ppm level is very important in industries. CGCRI has developed the device to detect moisture in the range of 0-1000 Pm based on micro and nano-porous alumina sensors. Measurement of moisture in gases in glove boxes as well as industrial environment involving high quality welding, nuclear reactors, food packaging pharmaceuticals, laser marking, submarine periscope purging etc. are some of the important areas of application of trace moisture analyzer.

### Ceramic Gas Sensors for Methane and Carbon Monoxide in Mines:

Prototype gas-leak detectors containing thick film metal oxide semiconductor sensing elements for detection of toxic and combustible gases like carbon monoxide, methane and LPG have been developed at the institute. Novel double coated sensors have also been developed to eliminate interference from volatile organic compounds which emanate from different organic solvents present in domestic and industrial products, The double coated sensors can detect methane or carbon monoxide in the presence of such volatile organic compounds.

### Testing and Calibration

In parallel to the activities of R&D on traditional ceramics as well as futuristic areas, the institute offers excellent testing and evaluation services to help industries in their quality assurances programmes. The institute is one of the first couple of CSIR laboratories to receive accreditation from National Accreditation Board of Laboratories for Testing and Calibration (NABL), Govt. of India for its testing facilities. The Refractory Division of the institute has also been accredited with ISO-9001.

With changing times Central Glass and Ceramic Research Institute is gearing up to meet new challenges. Keeping in view the need for securing patents, the institute has put in place a fully operational patent cell. This cell advises researchers on the importance of patents and guides them in filing application for patents. Queries on patents from outside the institute are also entertained. The knowledge of the scientists in charge of this cell is helping other scientists to chart their way through the labyrinth of the patent-arena.

The CGCRI is arranging Institute-Industry interaction in order to gain a first hand knowledge about the merits and inadequacies of its products from the industry's viewpoint. It is common knowledge that in many a cases inventions made by researches institutes remain lab-scale and thus fail to meet industrial requirements. The interaction sessions have shed light on the need for upgrading some of CGCRI's inventions to land or factory scale proportions.

Apart from its R&D activities that help the society in different ways, CGCRI has always been keen on maintaining a direct contact with the society. On National days the Institute organises functions where lectures delivered by eminent scientists are attended by students of schools from the neighbourhood. These lectures include topics on India's technological heritage which infuse the students with a sense of pride about the past of the nation. Laboratory visits for meritorious students are also organised under different schemes in collaboration with other national academic institutions.

Thus the Institute takes every pain to extend its helping hand to the society, for the service of which it exists.

*52/1, Netaji Subhash Road, P.O. New Barrackpore,
24- Prganas (North), Pin-700 131

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## Letters to the Editor

*I have read the article published about 'Omar Khayyam'. It is very interesting to know that not only he was a great poet, but also an astronomer and contributed in the field of algebra. That 'Rubaiyat' poem published, took me to that Persian medieval time. Really, that has given civilization to the world. The information was really useful.*

**Dr. Ram Shanmugan**
Central Institute of Orthopaedics, Safdarjang Hospital, New Delhi-110029

*I have found "Dream-2047" magazine very informative, educative particularly to the persons who want to know about science. This magazine is also useful as a reference for the scientists delivering lectures in schools and other institutions for promoting science.*

**J.R. Thakur**
Associate Director (R&E), Regional Horticultural Research Station
Dr. Y.S. Parmar University of Horticulture & Forestry, Bajaura, Kullu (H.P) 175125

*Congratulations to you and your co-workers for sustained efforts in bringing up a leading news letter for propagation of science in this country. Our long cherished dream has come to reality through "Dream-2047". Yet there is a long way to go to come closer to the masses.*

**Dr. Mihir K. Bose**
Deptt. of Geology, Presidency College
86/1 College street, Kolkata – 700 073

*When I got "Dream-2047" January 2003 for the first time, I read it in details and found that this is very much helpful in improving the knowledge of science and Technology.*

**Nihal J. Saudagar**
Head master, Rashtriya Vidyalaya
Takli (Valandi) Distt. Latoor (Maharashtra)