



# DREAM 2047

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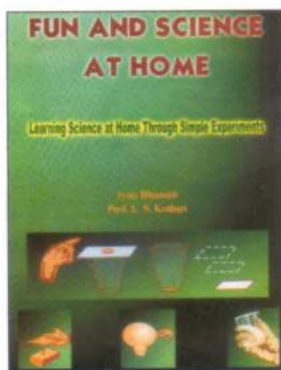
No. 3

## VP News

## Inside

### Learning Science Through Experiments

Learning science is fun and joyful. Any doubts? Pick up the latest book written by Jyoti Bhansali and Prof. L S Kothari. The book, "Fun and Science at Home", takes you to the fascinating world of science through some 120 simple and exciting science-related experiments that any child at an age of 8 and above can do at home. These experiments that require only cheap and ordinary objects used in everyday life are classified under broad topics such as air, water, sound, light, forces, and heat. The authors also include a few general activities in the book.

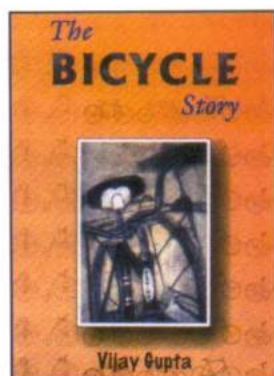


Apart from elaborately explaining how these experiments are to be done, the book clearly describes the science behind each experiment, thus making children understand many scientific principles they learn in schools better. Not just children, even adults will find many of the

experiments described in the book educative and interesting. This book, by all means, could serve a good resource material for teachers teaching science up to higher secondary levels.

"Fun and Science at Home", By Jyoti Bhansali and Prof. L S Kothari, Published by Vigyan Prasar, 2001, pp: 124+vi, ISBN: 81-7480-078-6, Rs. 75/-

### The Story of Bicycle



It has been the endeavour of Vigyan Prasar to popularise the science behind things we see, we hear and we use everyday through its publications. Continuing with this tradition, we this month publish a book, "The Bicycle Story", written by Vijay Gupta, Professor of Aerospace Engineering at the Indian Institute of Technology (IIT), Kanpur. Written in a simple

#### EDITORIAL

- ☛ Srinivasa Ramanujan :
- ☛ Facts about anthrax
- ☛ Fighting Anthrax - The Indian Effort
- ☛ Towards an Environmentally sound society
- ☛ Recent Development in Science and Technology



Dr. Hari Krishna Devsare, Fellow, Vigyan Prasar was presented 'Balsahitya Bharti' Award for his contributions to children's literature at a function held at Lucknow on 8th December 2001. The award was presented by His Excellency Shri Vishnu Kant Shastri, Governor, U.P. Shri Kesari Nath Tripathi, Hon'ble Speaker, U.P. Vidhan Sabha was also present on the occasion.

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

## Popularizing Science Through *Matri-Bhasha*

Phenomenal growth in literacy ratio over the years, a higher level of general awareness among the people, and their growing participation in the decision making process have posed new challenges to science communicators in their tasks. With nearly three-fourths of the males and over half of the females being literate, the next step would be to help them understand and appreciate issues directly affecting their lives which may include issues like health, environment, sanitation and hygiene, nutrition, appropriate technology, means of income generation and the like; and that too without any conscious effort to inculcate a scientific temper among them. In order to bring them into the national mainstream, however, it would be necessary to put in efforts to help them attain a level when they can read newspapers / magazines with sufficient ease.

When we read a newspaper, we can follow with ease, understand, and interpret news items related to education, sports, politics and so on. If we can understand with the same ease news items / articles on topics like PSLV and GSLV launches, genetically modified foods, use of CNG for transport, anthrax as a biological weapon and so on, it could be said that we are scientifically literate. It is then that one can actively participate in the decision making process. This, however, implies information on and understanding of recent scientific developments and working knowledge of gadgets we come across in our daily lives. It may also require familiarity with a few scientific principles and natural phenomena. For example, information about AIDS or Dengue and how they spread could help us keep them at bay. Knowledge and information about ORS (oral re-hydration solution) could help save lives of thousands of infants. The challenge before science communicators is then imparting information on and interpreting such items and issues in a language and manner acceptable to the people.

However, imparting or acquiring information alone would serve little purpose. It is necessary to help people learn to organize, analyze and apply the information to arrive at a solution and understand the environment they live in - physical or social. Whatever the topic and whatever the media, scientific approach must reflect in the articles we write or radio / television programmes we produce. This means balanced reporting with objective analysis of different news rather than one-sided view or a story with hype and sensationalism. Media are expected to act as a mirror - be it newspaper, radio or TV - and reflect the true picture of the society; but this is possible only if the mirror itself is not distorted.

Making people scientifically literate, however, does not imply reproducing articles from research journals in local newspapers alone or translating them into a language even a person well versed in that language may find difficult to comprehend! A major effort is therefore called for to simplify the language of communication and develop terminology with words and phrases employed in daily life. Sometimes it is desirable to retain the original terms as they are if they have already been accepted in the language of translation rather than attempt a contrived translation (say *Vikiranadharmita* for radioactivity or *Gandhakamla* for sulphuric acid). There is no gainsaying the fact that every region speaking a particular language will have to evolve its own language with local nuances for science communication whatever the media employed. What is more, we shall have to learn to think in *Matri-Bhasha* if we hope to communicate science and technology to the people effectively.

Original articles / books written in one regional language also may need to be translated into other regional languages. Maybe we shall need to set up translation bureaus for this purpose as suggested by Shri M. V. Kamath, well known journalist, and President, Vigyan Prasar, in a recent meeting on science communication in Marathi at Mumbai. It is heartening to note that leading scientists like Professor J. V. Narlikar and a few others have taken upon themselves the task of taking science to the people in regional languages with a missionary zeal, and have inspired a whole lot of the younger generation to follow the suit. Of late, there has been a discernible growth in publication of popular science books / magazines in the regional languages. Government agencies like NBT, NCSTC, Vigyan Prasar, and several non-Government organisations have also significantly contributed to accelerate the process.

Many of us - scientists, science communicators, social workers, students, teachers, administrators, etc., have been actively engaged in a variety of societal problems in a bid to transform our country into a nation of not just literate, but scientifically literate and scientifically minded people. For this purpose, it is imperative that we start thinking and writing in *Matri-Bhasha*.

□ V.B. Kamble

Editor : V.B. Kamble

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## Srinivasa Ramanujan : A Remarkable Mathematical Genius

□ Subodh Mahanti

Ramanujan's brief life and death are symbolic of conditions in India. Of our millions how few get any education at all; how many live on the verge of starvation.  
Jawaharlal Nehru in his *Discovery of India*

Sheer intuitive brilliance coupled to long, hard hours on his slate made up for most of his educational lapse. This 'poor and solitary Hindu pitting his brains against the accumulated wisdom of Europe' as Hardy called him, had rediscovered a century of mathematics and made new discoveries that would captivate mathematicians for next century.

Robert Kanigel in *The Man who Knew Infinity : A Life of the Genius Ramanujan*

I still say to myself when I am depressed and find myself forced to listen to pompous and tiresome people, 'Well, I have done one thing you could never have done, and that is to have collaborated with both Littlewood and Ramanujan on something like equal terms'.

Godfrey Harold Hardy

"Ramanujan's life", as Robert Kanigel, the author of a marvellous biography of Ramanujan, wrote, "can be made to serve as parable for almost any lesson you want to draw from it." Ramanujan's example stirred the imagination of many—particularly that of mathematicians.

Thus, Subrahmanyan Chandrasekhar (1910-95), the Indian born astrophysicist, who got Nobel Prize in 1983, said: "I think it is fair to say that almost all the mathematicians who reached distinction during the three or four decades following Ramanujan were directly or indirectly inspired by his example." Even those who do not know about Ramanujan's work are bound to be fascinated by his life. As Kanigel wrote: "Few can say much about his work, and yet something in the story of his struggle for the chance to pursue his work on his own terms compels the imagination, leaving Ramanujan a symbol for genius, for the obstacles it faces, for the burden it bears, for the pleasure it takes in its own existence."

Ramanujan's life is full of strange contrasts. He had no formal training in mathematics but yet "he was a natural mathematical genius, in the class of Gauss and Euler." Probably Ramanujan's life has no parallel in the history of human thought. Godfrey Harold Hardy, (1877-1947), who made it possible for Ramanujan to go to Cambridge and give formal shape to his works, said in one of his lectures given at Harvard University (which later came out as a book entitled *Ramanujan: Twelve Lectures on Subjects Suggested by His Life and Work*): "I have to form myself, as I have never really formed before, and try to help you to form, some of the reasoned estimate of the most romantic figure in the recent history of mathematics, a man whose career seems full of paradoxes and contradictions, who defies all canons by which we are accustomed to judge one another and about whom all of us

will probably agree in one judgement only, that he was in some sense a very great mathematician."

Srinivasa Ramanujan Iyengar (best known as Srinivasa Ramanujan) was born on December 22, 1887, in Erode about 400 km from Chennai, formerly known as Madras where his mother's parents lived. After one year he was brought to his father's town, Kumbakonam. His parents were K. Srinivasa Iyengar and Komalatammal. He passed his primary examination in 1897, scoring first in the district and then he joined the Town High School. In 1904 he entered Kumbakonam's Government College as F.A. student. He was awarded a scholarship. However, after school, Ramanujan's total concentration was focussed on mathematics. The result was that his formal education did not continue for long. He first failed in Kumbakonam's Government College. He tried once again in Madras from Pachaiyappa's College but he failed again.



Srinivasa Ramanujan

While at school he came across a book entitled *A Synopsis of Elementary Results in Pure and Applied Mathematics* by George Shoobridge Carr. The title of the book does not reflect its contents. It was a compilation of about 5000 equations in algebra, calculus, trigonometry and analytical geometry with abridged demonstrations of the propositions. Carr had compressed a huge mass of mathematics that was known in the late nineteenth century within two volumes. Ramanujan had the first one. It was certainly not a classic. But it had its positive features. According to Kanigel, "one strength of Carr's book was a movement, a flow to the formulas seemingly laid down one after another in artless profusion that gave the book a sly seductive logic of its own." This book had a great influence on Ramanujan's career. However, the book itself was not very great. Thus Hardy wrote about the book: "He (Carr) is now completely

forgotten, even in his college, except in so far as Ramanujan kept his name alive". He further continued, "The book is not in any sense a great one, but Ramanujan made it famous and there is no doubt it influenced him (Ramanujan) profoundly". We do not know how exactly Carr's book influenced Ramanujan but it certainly gave him a direction. 'It had ignited a burst of fiercely single-minded intellectual activity'. Carr did not provide elaborate demonstration or step by step proofs. He simply gave some hints to proceed in the right way. Ramanujan took it upon himself to solve all the problems in Carr's Synopsis. And as E. H. Neville, an English mathematician, wrote: "In proving one formula, as he worked through Carr's synopsis, he discovered many others, and he began the practice of compiling a notebook." Between 1903 and 1914 he had three notebooks.

While Ramanujan made up his mind to pursue mathematics forgetting everything else but then he had to work under extreme hardship. He could not even buy enough paper to record the proofs of his results. Once he said to one of his friends, "when food is problem, how can I find money for paper? I may require four reams of paper every month." In fact Ramanujan was in a very precarious situation. He had lost his scholarship. He had failed in examination. What is more, he failed to prove a good tutor in the subject which he loved most.

At this juncture, Ramanujan was helped by R. Ramachandra Rao, then Collector of Nellore. Ramchandra Rao was educated at Madras Presidency College and had joined the Provincial Civil Service in 1890. He also served as Secretary of the Indian Mathematical Society and even contributed solution to problem posed in its *Journal*. The Indian Mathematical Society was founded by V. Ramaswami Iyer, a middle-level Government servant, in 1906. Its *Journal* put Ramanujan on the world's mathematical map. Ramaswami Iyer met Ramanujan sometime late in 1910. Ramaswami Iyer gave Ramanujan notes of introduction to his mathematical friends in Chennai (then Madras). One of them was P.V. Seshu Iyer, who earlier taught Ramanujan at the Government College. For a short period (14 months) Ramanujan worked as



Komalatammal :  
Ramanujan's mother



E.H. Neville

clerk in the Madras Port Trust which he joined on March 1, 1912. This job he got with the help of S. Narayana Iyer.

Ramanujan's name will always be linked to Godfrey Harold Hardy, a British mathematician. It is not because Ramanujan worked with Hardy at Cambridge but it was Hardy who made it possible for Ramanujan to go to Cambridge. Hardy, widely recognised as the leading mathematician of his time, championed pure mathematics and had no interest in applied aspects. He discovered one of the fundamental results in population genetics which explains the properties of dominant, and recessive genes in large mixed population, but he regarded the work as unimportant.

Encouraged by his well-wishers, Ramanujan, then 25 years old and had no formal education, wrote a letter to Hardy on January 16, 1913. The letter ran into eleven pages



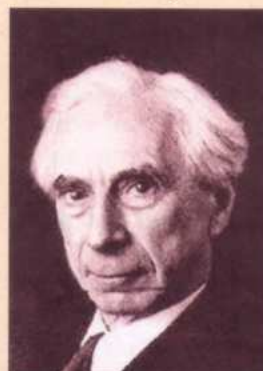
Godfrey Harold Hardy

and it was filled with theorems in divergent series. Ramanujan did not send proofs for his theorems. He requested Hardy for his advice and to help getting his results published. Ramanujan wrote: "I beg to introduce myself to you as a clerk in the Accounts Department of the Port Trust Office at Madras on a salary of only £ 20 per annum. I have had no university education but I have undergone the ordinary school course. After leaving school I have been employing the spare time at my disposal to work at mathematics. I have not trodden through the conventional regular course which is followed in a university course, but I am striking out a new path for myself. I have made a special investigation of divergent series in general and the results I get are

termed by the local mathematicians as "startling"... I would request you to go through the enclosed papers. Being poor, if you are convinced that there is anything of value I would like to have my theorems published. I have not given the actual investigations nor the expressions that I get but I have indicated the lines on which I proceed. Being inexperienced I would very highly value any advice you give me". The letter has become an important historical document. In fact, 'this letter is one of the most important and exciting mathematical letters ever written'. At the first glance Hardy was not impressed with the contents of the letter. So Hardy left it aside and got himself engaged in his daily routine work. But then he could not forget



Karl Gustav Jacob Jacobi



Bertrand Russell

about it. In the evening Hardy again started examining the theorems sent by Ramanujan. He also requested his colleague and a distinguished mathematician, John Edensor Littlewood (1885-1977) to come and examine the theorems. After examining closely they realized the importance of Ramanujan's work. As C.P. Snow recounted, 'before midnight they knew and knew for certain' that the writer of the manuscripts was a man of genius'. Everyone in Cambridge concerned with mathematics came to know about the letter. Many of them thought 'at least another Jacobi in making had been found out'. Bertrand Arthur William Russell (1872-1970) wrote to Lady Ottoline Morell. "I found Hardy and Littlewood in a state of wild excitement because they believe, they have discovered a second Newton, a Hindu Clerk in Madras ... He wrote to Hardy telling of some results he has got, which Hardy thinks quite wonderful."

Fortunately for Ramanujan, Hardy realised that the letter was the work of a genius. In the next three months Ramanujan received another three letters from Hardy. However, in the beginning Hardy responded cautiously. He wrote on 8 February 1913. To quote from the letter. "I was exceedingly interested by your letter and by the theorems which you state. You will however understand that, before I can judge properly of the value of what you have done it is essential that I should see proofs of some of your assertions ... I hope very much that you will send me as quickly as possible at any rate a few of your proofs, and follow this more at your leisure by more detailed account of your work on primer and divergent series. It seems to me quite likely that you have done a good deal of work worth publication; and if you can produce satisfactory demonstration I should be very glad to do what I can to secure it".

In the meantime Hardy started taking steps for bringing Ramanujan to England. He contacted the Indian Office in London to this effect. Ramanujan was awarded the first research scholarship by the Madras University. This was possible by the recommendation of Gilbert Walker, then Head of the Indian Meteorological Department in Simla. Gilbert was not a pure mathematician but he was a former Fellow and mathematical lecturer at Trinity College, Cambridge. Walker, who was prevailed upon by Francis Spring to look through Ramanujan's notebooks wrote to the Registrar of the Madras University: "The character of the work that I saw impressed me as comparable in originality with that of a Mathematical Fellow in a Cambridge College; it appears to lack, however, as might be



Evariste Galois

expected in the circumstances, the completeness and precision necessary before the universal validity of the results could be accepted. I have not specialised in the branches of pure mathematics at which he worked, and could not therefore form a reliable estimate of his abilities, which might be of an order to bring him a European reputation. But it was perfectly clear to me that the University would be justified in enabling S. Ramanujan for a few years at least to spend the whole of his time on mathematics without any anxiety as to his livelihood."

Ramanujan was not very eager to travel abroad. In fact he was quite apprehensive. However, many of his well-wishers prevailed upon him and finally Ramanujan left Madras by S.S. *Navesa* on March 17, 1914. Ramanujan reached Cambridge on April 18, 1914. When Ramanujan reached England he was fully abreast of the recent developments in his field. This was described by J. R. Newman in 1968: "Ramanujan arrived in England abreast and often ahead of contemporary mathematical knowledge. Thus, in a lone mighty sweep, he had succeeded in recreating in his field, through his own unaided powers, a rich half century of European mathematics. One may doubt whether so prodigious a feat had ever been accomplished in the history of thought."

Today it is simply futile to speculate about what would have happened if Ramanujan had not come in contact with Hardy. It could happen either way. But then Hardy should be given due credit for recognizing Ramanujan's originality and helping him to carry out his work. Hardy himself was very clear about his role. "Ramanujan was", Hardy wrote, "my discovery. I did not invent him — like other great men, he invented himself — but I was the first really competent person who had the chance to see some of his work, and I can still remember with satisfaction that I could recognize at once what I treasure I had found."

It may be noted that before writing to Hardy, Ramanujan had written to two well-known Cambridge mathematicians viz., H.F. Baker and E.W. Hobson. But both of them had expressed their inability to help Ramanujan.

Ramanujan was awarded the B.A. degree in March 1916 for his work on 'Highly composite Numbers' which was published as a paper in the Journal of the London Mathematical Society. He was the second Indian to become a Fellow of the Royal Society in 1918 and he became one of the youngest Fellows in the entire history of the Royal Society. He was elected "for his investigation in Elliptic Functions and the Theory of Numbers." On 13 October 1918



A postage stamp released by Govt. of India in 1962



Subrahmanyan Chandrasekhar

he was the first Indian to be elected a Fellow of Trinity College, Cambridge.

Much of Ramanujan's mathematics comes under the heading of number theory — a purest realm of mathematics.

The number theory is the abstract study of the structure of number systems and properties of positive integers. It includes various theorems about prime numbers (a prime number is an integer greater than one that has not integral factor). Number theory includes analytic number theory, originated by Leonhard Euler (1707-89); geometric theory - which uses such geometrical methods of analysis as Cartesian co-ordinates, vectors and matrices; and probabilistic number theory based on probability theory. What Ramanujan did will be fully understood by a very few. In this connection it is worthwhile to note what Hardy had to say of the work of pure mathematicians: "What we do may be small, but it has certain character of permanence and to have produced anything of the slightest permanent interest, whether it be a copy of verses or a geometrical theorem, is to have done something beyond the powers of the vast majority of men." In spite of abstract nature of his work Ramanujan is widely known.

Ramanujan was a mathematical genius in his own right on the basis of his work alone. He worked hard like any other great mathematician. He had no special, unexplained power. As Hardy, wrote: "I have often been asked whether Ramanujan had any special secret; whether his methods differed in kind from those of other mathematicians; whether there was anything really abnormal in his mode of thought. I cannot answer these questions with any confidence or conviction; but I do not believe it. My belief that all mathematicians think, at bottom, in the same kind of way, and that Ramanujan was no exception."

Of course, as Hardy observed Ramanujan "combined a power of generalization, a feeling for form and a capacity for rapid modification of his hypotheses, that were often really startling, and made him, in his peculiar field, without a rival in his day.

Here we do not attempt to describe what Ramanujan achieved. But let us note what Hardy had to say about the importance of Ramanujan's work. "Opinions may differ as to the importance of Ramanujan's work, the kind of standard by which it should be judged and the influence which it is likely to have on the mathematics of the future. It has not the simplicity and the inevitableness of the greatest work; it would be greater if it were less strange. One gift it shows which no one will deny—profound and invincible originality."



The statue of Ramanujan made by the American Architect Paul Grandlund



Leonhard Euler



Niels Henrik Abel

The Norwegian mathematician Atle Selberg, one of the great number theorists of this century wrote: "Ramanujan's recognition of the multiplicative properties of the coefficients of modular forms that we now refer to as cusp forms and his conjectures formulated in this connection and their later generalization, have come to play a more central role in the mathematics of today, serving as a kind of focus for the attention of quite a large group of the best mathematicians of our time. Other discoveries like the mock-theta functions are only in the very early stages of being understood and no one can yet assess their real importance. So the final verdict is certainly not in, and it may not be in for a long time, but the estimates of Ramanujan's nature in mathematics certainly have been growing over the years. There is doubt no about that."

Often people tend to speculate what Ramanujan would have achieved if he had not died or if his exceptional qualities were recognised at the very beginning. There are many instances of such untimely death of gifted persons, or rejection of gifted persons by the society or the rigid educational system. In

mathematics we may cite the cases of Niels Henrik Abel (1809-29) and Evarista Galois (1811-32). Abel solved one of the great mathematical problems of his day - finding a general solution for a class equations called quintiles. Abel solved the problem by proving that such a solution was impossible. Galois pioneered the branch of modern mathematics known as group theory. What is important is that we should recognise the greatness of such

people and take inspiration from their work.

Even after more than 80 years of the death of Ramanujan the situation is not very different as far the rigidity of the education system. Today also a 'Ramanujan' is not likely to get a chance to pursue his career. This situation remains very much similar as described by JBS Haldane (1982-1964), a British born geneticist and philosopher who spent last part of his life in India. Haldane said: "Today in India Ramanujan could not get even a lectureship in a rural college because he had no degree. Much less could he get a post through the Union Public Service Commission. This fact is a disgrace to India. I am aware that he was offered a chair in India after becoming a Fellow of the Royal Society. But it is scandalous that India's great men should have to wait for foreign recognition. If Ramanujan's work had been recognised in India as early it was in England, he might never have emigrated and might be alive today. We can cast the blame for Ramanujan's non-recognition on the British Raj. We cannot do so when similar cases occur today..."

Nehru's statement given at the beginning is very much valid even today. And for these very reasons **the story of Ramanujan should be told and retold to our younger people particularly to those who aspire to do something extraordinary but feel dejected under the prevailing circumstances.** And in this connection it is worthwhile to remember what Chandrasekhar had to say: "I can recall the gladness I felt at the assurance that one brought up under circumstances similar to my own could have achieved what I could not grasp. The fact that Ramanujan's early years were spent in a scientifically sterile atmosphere, that his life in India was not without hardships that under circumstances that appeared to most Indians as nothing short of miraculous, he had gone to Cambridge, supported by eminent mathematicians, and had returned to India with very assurance that he would be considered, in time as one of the most original mathematicians of the century — these facts were enough, more than enough, for aspiring young Indian students to break their bands of intellectual confinement and perhaps soar the way what Ramanujan had."



Janaki : Ramanujan's wife

As someone has written "Ramanujan did mathematics for its own sake, for thrill that he got in seeing and discovering unusual relationships between various mathematical objects." Today Ramanujan's work has some applications in particle physics or in the calculation of pi up to a very large number of decimal places. His work on Riemann's Zeta Function has been applied to the pyrometry, the investigations of the temperature of furnaces. His work on the Partition Numbers resulted in two applications — new fuels and fabrics like nylons. But then highlighting the importance of the application side Ramanujan's work is

really not very important.

Ramanujan died of tuberculosis in Kumbakonam on April 26, 1920. He was only 32 years old. "It was always maths ... Four days before he died he was scribbling," said Janaki, his wife. The untimely death of Ramanujan was most unfortunate particularly so when we take into account the circumstances under which he died. As *Times Magazine* rightly wrote: "There is something peculiarly sad in the spectacle of genius dying young, dying with the first sweets of recognition and success tasted, but before the full recognition of powers that lie within."

The only Ramanujan Museum in the country, founded by Shri P. K. Srinivasan, a mathematics teacher, operates from March 1993 in the Avvai Academy, Royapuram, Madras.

The achievement of Ramanujan was so great that those who can really grasp the work of Ramanujan 'may doubt that so prodigious a feat had ever been accomplished in the history of thought'.

### Further Reading

1. Ramanujan: Twelve Lectures on the *Subjects Suggested by His Life and Work* by G. H. Hardy, Chelsea Publishing Co, New York, 1940.
- 2) *The Man Who Knew Infinity : A Life of the Genius Ramanujan* by R. Kanigel, Abacus Books, London, 1992.
- 3) *Ramanujan's Notebooks* (Part I&II) by B.C. Berndt Springer, New York, 1985-1989.
- 4) *Ramanujan: The Man and the Mathematician* by S.R. Ranganathan, Asia Publishing House, Bombay, 1967.
- 5) *Srinivasa Ramanujan : A Mathematical Genius* by K. Srinivasa Rao; East West Books (Madras) Pvt. Ltd. 1998.
- 6) *Srinivasa Ramanujan*, Suresh Ram, National Book Trust India, 1989.
- 7) *Ganit Jagater Bismay Ramanujan* by Satyabachi Sar, Gyan Bichitra Prakashani, Agartala, 2000. A well-written book in Bengali.

### VP News Contd.....

and lucid language, this book retraces the history and evolution of bicycle, which is undoubtedly the vehicle of common man world over. Besides chronicling technological advances the bicycle has gone through since its crudest form appeared on the scene some 300 years ago, the author touches upon some interesting facts about it. According to Prof. Gupta, bicycle is the most efficient vehicle ever designed by man. Its cost, in terms of energy spent in carrying a comparable load over a comparable distance, is one-tenth of that of the most efficient jet aircraft and about one-twentieth of the best automobile!

The book also seeks to explain, along with illustrations, various engineering designs tried and tested during the span of three centuries in different parts of the world in order to arrive at its present form of a highly efficient transportation and leisure vehicle. This process of evolution of design was slow sometimes and rapid at other times, each stage leading to an improved product.

Through the book, the author explores the possibility of introducing some essential principles of engineering mechanisms such as treadles, cranks, velocity ratio, transmission, gearing, anti-friction bearing, etc. He also discusses the science of bicycling through discussions on force and power, wind resistance, braking and stability in the book.

*The Bicycle Story*, By Vijay Gupta, Published by Vigyan Prasar 2001, pp 40+iv, ISBN:81-7480-073-5, Rs. 25/-



Dr. Hari Krishna Devsare, Fellow, Vigyan Prasar received another award from Hindi Akademy Delhi, for his book 'Bal Sahitya Mera Chintan'. The award was presented by noted Hindi Writer Ms. Krishna Sobti. Also present was Shri Janardan Dwivedi Vice-president, Hindi Akademy, Delhi.

## Anthrax - A Deadly Disease

□ S. K. Varshney\*

**A**nthrax is one of the most hated words today. A number of human fatalities had been reported in October especially, from the United States and Kenya, and in India too several reported cases were under investigations. People were scared of opening their mail received from unknown sources. On the other hand, those on public duty just could not have afforded to say no to read their correspondences.

A majority of persons do not know what this Anthrax is, why people are so afraid and concerned, how does it affect the human system, whether some preventive vaccination is required and how seriously we should take it in India. Before the recent crisis was explained, let us see how Anthrax occurs in nature and whom it affects in normal circumstances.

Anthrax is an acute bacterial infection caused by spore\* forming *bacillus anthracis* which primarily affects wild and domestic lower vertebrates (cattle, sheep, goats, camels, antelopes, and other herbivores). It can occasionally spread to humans also, when they are exposed to infected animals or tissues from infected animals, affecting the skin, intestine or lungs. In humans, the infection can often be treated, but it is almost fatal in animals.

The bacterium and its associated disease get their names from the Greek word "Anthra" meaning coal because of the characteristic coal-black sore which is a hallmark of the most common form of this disease. It is also known as "ragpicker's" and "wool-sorter's" disease, mainly because workers contracted the disease from bacterial spores present on the animal skin. The largest outbreak ever recorded in the United States occurred in 1957 when nine employees of a goat hair processing plant became ill after handling a contaminated shipment from Pakistan.

Animals acquire the disease from drinking water from contaminated soil, in which the infectious bacteria may live for years; from eating infected carcasses and feedstuffs; and from the bites of bloodsucking insects. The disease, sometime manifested by staggering, bloody discharge, convulsions, and suffocation, may be fatal almost



A culture of bacillus anthracis

immediately or within 3-5 days. Death is caused by toxemia.

Anthrax can occur in human beings in three forms: cutaneous (skin), inhalation and gastrointestinal. *B. anthracis* spores can live in soil for many years and human beings can get infected by handling products from infected animals or by inhaling anthrax spores from contaminated products. Anthrax can also spread by eating undercooked meat from infected animals. Symptoms of disease vary depending upon how the disease was contracted, but symptoms occur usually within 7 days.

**Cutaneous:** Most (about 95%) anthrax infections occur when the bacterium enters a cut or abrasion on the skin, such as when handling contaminated wool, hides, leather or hair products (especially goat hair) of infected animals. Skin infection begins as a raised itchy bump that resembles an insect bite but within 1-2 days develops into a vesicle and then a painless ulcer, usually 1-3 cm in diameter, with a characteristic black necrotic (dying) area in the centre.

Lymph glands in the adjacent areas may swell. About 20% of untreated cases of cutaneous anthrax may result in death.

**Inhalation or Pulmonary:** It develops because of inhaling anthrax spores, as from animal hair and wool, which invades the lungs and sometime may spread to the brain. Initial

symptoms resemble a common cold, but after several days, the symptoms may progress to severe breathing problems and shock. Inhalation anthrax is almost fatal, even if treated within 1-2 days after symptoms appear.

**Intestinal:** It may follow consumption of contaminated meat and is characterized by acute inflammation of the intestinal tract. Initial signs of nausea, loss of appetite, vomiting, fever are followed by abdominal pain, vomiting of blood and severe diarrhoea. Intestinal anthrax results in death in 25-50% cases.

Anthrax is diagnosed by detecting *B. anthracis* in samples taken from blood, skin lesions or respiratory secretions. Using biochemical techniques, anthrax bacterium is made to fluoresce. Blood samples also indicate elevated antibody levels or increased amounts of protein produced directly in response to infection with the anthrax bacterium. Additional DNA-based tests are also being perfected.

Louis Pasteur perfected the first anthrax vaccine in

\* Spore is a dormant form assumed by bacteria, such as anthrax, that enables the bacterium to survive high temperatures, dryness, and lack of nourishment for long periods of time. Under proper conditions, the spore may revert to actively multiplying form of the bacteria.

### Why anthrax is a potent biological weapon

Anthrax, which is otherwise a disease of animals, caught the imagination of military scientists who develop biological weapons little over 80 years ago. The first ever reported case of anthrax use for military purpose dates back to World War One when German spies allegedly targeted allied pack animals in Norway.

Anthrax has several qualities that a potent biological weapon requires. Its spores are tough, fairly easy to culture and have a long shelf-life. Besides, it is not contagious. That means only those exposed to a release of spores get sick and there is no chance that the germs will rebound on the attacker. Spores also survive delivery via bombs, shells or sprays better than many other pathogens. But, it is not easy to grow deadly anthrax and it is even harder to make it into a weapon. The spores have to be turned into a microscopically fine powder. An anthrax aerosol is odourless and invisible following release and has potential to travel many kilometres before disseminating.

Anthrax figured in every known bio-arsenal of the last century, including those of Britain, the US, Japan, the Soviet Union and Iraq. But no one ever used them in battle, although Japan did tests on humans. During the World War II Britain tested anthrax weapons by infecting a Scottish island, Gruinard, cleaning of which took decades subsequently.

An accidental release of anthrax spores from a military microbiology facility in Sverdlovsk in the former Soviet Union in 1979 resulted in at least 66 deaths. In 1970, a World Health Organisation (WHO) expert committee estimated that casualties following the theoretical aircraft release of 50 kilogram of anthrax over a developed urban population of 5 million would be 250,000 and 40% of the infected will die without getting any treatment.

1881. Today, anthrax is rare, even among cattle, largely because of widespread animal vaccination. However, some serious epidemics continue to occur among animal herds and in human settlements in developing countries due to ineffective control programme.

### Present outcry

Recent terrorist attacks have focussed new attention on biological agents that could be used as weapons. Among these, anthrax has caused the most immediate concern after a number of people across the world have been exposed to anthrax sent through mail. It is now confirmed that letter opened in US Senate Majority Leader, Tom Dasche, had anthrax in it. The anthrax scare began in Florida on October 4 when it was established that an editor at the tabloid "Sun" had contracted the inhaled form of the bacteria. He later died, the first such death in US since 1976. News of exposures has caused jitters, with a number of false or hoax calls coming in.

A particular virulent form of inhaled anthrax, often called as battlefield anthrax, has been used for biological warfare. When a person inhales spores of *B. anthracis*, the microbes unleash three proteins, which combine to form a toxin. This triad makes blood pressure plummet, causes haemorrhaging, and can lead to coma and death. This anthrax strain is fatal even if antibiotics have been administered within 12 hours. The worst outbreak of this warfare occurred in 1979, when a biological weapons plant in Sverdlovsk, Russia (present-day Yekaterinburg), accidentally released airborne anthrax spore, killing 66 persons.

Science is a quest for knowledge, to know how things occur in nature, and also to learn their behaviour in given

sets of conditions. Technology, on the other hand, helps in shaping up required products. It is expected that science and technology lead to the development of humankind. Evil spirits have tried time and again to misutilize the newly gained knowledge to their advantage at the human cost, and anthrax is no exception.

It is being suspected that following the events on the September 11, after which the US and its friendly countries tried to retaliate, terrorists with little muscle or armament power used it as their saviour. Letters with sprinkled anthrax spores have been mailed. There were some casualties in United States and Kenya and rest of the world was under constant terror. In India too, the Communication Minister announced that all incoming foreign mails would be screened for anthrax first before post-office officials handle them. Though there is a great concern and some degree of panic also, there does not seem to be an immediate danger for India. It is felt that countries involved in present day war, may suffer on this count. In the United States, great shortage of the preventive medicine (Ciprofloxacin) is being experienced.

### Anthrax-Antidote

Scientists have created a synthetic compound that disables the toxin that makes the bacterial disease anthrax so lethal. Meanwhile, another research team has discovered a gene that protects mice against anthrax. These findings could lead to unraveling of the anthrax toxin and help clarify the mechanism by which it kills.

### Dos and Don'ts

Though no danger is foreseen in India, still it is good to take necessary precautions. Here are a few tips:

- Direct person to person spread of anthrax is extremely unlikely to occur. Human being can get it from infected animals only. Therefore there is no need to immunise or treat contacts of persons ill with anthrax, such as household contacts, friends or co-workers, unless they are also exposed to the same source of infection.
- Vaccination against anthrax is not recommended for general public, including those persons, who are likely to be exposed because of direct animal contacts, like butcher, wool-man, etc. They may take necessary medicines (antibiotics) in consultation with their doctor.
- Military Personnel, who may be the target of biological weapons, may take preventive vaccination.
- Do not take vaccine intended for animal use.
- Pregnant ladies should not take any medication without consulting their doctors.
- Do not accept packets, letters from unspecified senders; If for certain reasons, they can't be refused, please look for white or brownish spores; In case of doubt, please give a hot iron treatment to the incoming letters and parcel, before opening them.

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## Fighting Anthrax - The Indian Effort

### Interview with Prof. Rakesh Bhatnagar

□ T. V. Jayan\*

In what could be described as a significant achievement in the fight against anthrax, a potent biological weapon, Indian scientists have bio-engineered a new vaccine which is less toxic and more effective than those currently available in the market.

The candidate vaccine, developed by a team of researchers, led by Prof. Rakesh Bhatnagar, Chairperson of the Centre for Biotechnology at the Jawaharlal Nehru University (JNU) in New Delhi, has already been transferred to pharmaceutical firm Panacea Biotech Ltd in the first week of November, for commercial production.

The JNU team's feat was widely acclaimed as the announcement came at a time the world was in the grip of an anthrax scare after five suspected anthrax related deaths in the United States in October and November. A numerous government and media offices in the U.S. were reportedly flooded with mails containing anthrax spores, in the aftermath of the September 11, 2001 attacks in New York and Washington.

What distinguishes the Indian candidate anthrax vaccine from those currently in use is its relatively less or no toxicity. The anthrax vaccines available today, when used for immunization, require a number of booster doses and have several undesirable side-effects.

Anthrax is a disease of grazing animals. The rod-shaped bacteria, *B. anthracis*, spend most of their time as spores in the soil, encased in a tough shell and practically lifeless. But when an animal swallows or inhales these spores, they come to life, and exude a protein which allows them to get into the white blood cells called macrophages. Though one of the major functions of macrophages is to destroy bacteria, fast-multiplying anthrax bacilli outmanoeuvre macrophages, and eventually leading to the death of the animal. Human beings who come in contact with animals that die of anthrax have a greater risk of contracting the disease.

Even though a 19<sup>th</sup> century scientist Robert Koch postulated the existence of toxins of *B. anthracis*, it wasn't really known what actually enables the bacteria to cause harm to animals and human beings till H Smith and J Keppie unravelled the molecular mechanism behind the infection in 1954. They discovered that the anthrax toxin complex consists of three proteins: a cell-receptor binding protein known as protective antigen; and two enzymes, lethal factor and edema factor. Protective antigen – central component of anthrax toxin – makes it possible for the other two components to enter into the host cell. Subsequently, it was found that these proteins are not toxic all by themselves,

but when lethal factor and edema factor are combined with protective antigen, they form potent toxin.

This knowledge helped scientists to develop many vaccines against anthrax in the past, one of the more evolved so far being a cell-free filtrate vaccine, which was used by the US to immunize its armed personnel. A cell-free filtrate vaccine means that the vaccine contains no dead or live bacteria unlike live attenuated vaccines.

The Indian candidate vaccine, however, is claimed to be superior to the one being used by the U.S. Army. The Indian scientists reportedly managed to nullify several side-effects associated with anthrax vaccines by genetically modifying the proteins – protective antigen, lethal factor and edema factor. The scientists not only rendered these proteins to be used in the vaccine preparation harmless, but also successfully over-expressed them in safer hosts. They also manufactured a few grams of anthrax proteins in an experimental bioreactor in the laboratory, before passing the technology over for commercial production to Panacea Biotech Ltd, through Biotech Consortium Limited, an organization set up to commercialize the technologies developed through the Department of Biotechnology (DBT)

funding. Few grams of purified anthrax protein are equivalent to million doses of currently available vaccine, according to Prof. Bhatnagar.

The effort to develop an Indian anthrax vaccine had actually begun in 1995 with the DBT sanctioning a research grant to Prof. Bhatnagar and Dr. Yogendra Singh of the Centre for Biochemical Technology, a research laboratory under the aegis of the Council of Scientific and Industrial Research

(CSIR).

Dr. Singh, who associated with the project in the early stages of the project and helped develop harmless mutants of anthrax proteins, has been working on anthrax for 14 years in various Indian and U.S. laboratories. Recently, he independently developed a therapeutic agent, which is capable of neutralizing the effect of the anthrax toxin in post-antibiotic treatment. This molecule, for which he recently filed a U.S. patent, is a potential solution to one major hurdle in the treatment of anthrax – ineffectiveness of drugs after setting in of symptoms.

Dream 2047 spoke to Prof. Rakesh Bhatnagar to know more about candidate anthrax vaccine developed by his team. Following are the excerpts of the interview with Prof. Bhatnagar:

**Dream 2047:** Anthrax, a disease originally thought to affect animals, suddenly assumed significance with reports



Prof. Rakesh Bhatnagar



Dr. Yogendra Singh

of several cases of fatalities in the U.S soon after the September 11 attacks. What is the treatment currently available for anthrax? How significant is the role of vaccination in managing anthrax?

**Prof. Bhatnagar:** Antibiotics such as ciprofloxacin and penicillin are found to be effective in treating anthrax. But what makes them unpopular is the long duration of the treatment – it takes about two months to cure the disease. Besides, the treatment is not quite effective once the symptoms of the disease have set in. Hence, like most other diseases, in the case of anthrax too, prevention is better than cure.

**Dream 2047:** But there is another school of thought which says that vaccination may not be an absolute necessity in the case of anthrax as the disease is seldom widespread?

**Prof. Bhatnagar:** This is not true. Take the case of a poor farmer. Suppose one of his cattle infected with anthrax dies. And he peels off its skin to earn a little extra money. There is a probability that he might contract the disease in the process. If he consults a doctor complaining uneasiness, the chances are high that the doctor might prescribe paracetamol or some such drug to him. This is because anthrax has symptoms very similar to that of common cold – breathlessness, pain and fever. In such a scenario, it will be very difficult to save him, considering that inhalation anthrax – one of the most virulent forms – has a fatality rate of about 95 per cent.

**Dream 2047:** Anthrax vaccines have been in the market for quite some time. It is said that Louis Pasteur was the first scientist to develop a vaccine against anthrax about 120 years ago in 1881. How is the vaccine developed by your team at the Jawaharlal Nehru University is different from those currently available in the market?

**Prof. Bhatnagar:** What Pasteur developed in the 19<sup>th</sup> century was a live attenuated vaccine against anthrax. This means the bacterium itself was injected to develop immunity. In the early 50s, scientists identified three molecules responsible for the virulence. They are protective antigen, lethal factor and edema factor. These proteins all by themselves are not toxic. But when protective antigen combines with lethal factor, lethal toxin is generated. Similarly, mixing edema factor with protective antigen creates an edema toxin, which causes swelling and redness of the skin. The preparations (other anthrax vaccines) currently used contain protective antigen, which is the principal immunogen, and traces of lethal factor and edema factors. These preparations have several undesirable side effects due to contamination of these proteins.

On the contrary, we introduced mutations into all three proteins of the anthrax toxin complex, rendering them non-toxic and free from side effects. In order to create an improved vaccine, we have introduced the genes for mutated proteins into relatively safe host organisms.

**Dream 2047:** At what stage is the development of new vaccine? When do you think the vaccine will be available for use?

**Prof. Bhatnagar:** We have intensively studied the

candidate vaccine at the cellular level. The lab scale technology has now been transferred to Panacea Biotech Ltd through Biotech Consortium India Ltd. This pharmaceutical company will conduct animal toxicity and clinical trials. They have collected the clones and the molecules from the lab and will produce the vaccine in larger amounts. Then they will have to do animal toxicity studies and subsequently the efficacy studies. Once they are ready with the data from the animal trials, they would approach the Drug Controller of India (DCI) for permission to carry out clinical trials on human beings.

We hope that the Indian anthrax vaccine will be in the market in nine months time. All that but will depend on successful completion of various trials on animals and human volunteers and the subsequent clearance from the DCI.

**Dream 2047:** How expensive would the vaccine be?

**Prof. Bhatnagar:** The new anthrax vaccine is certainly going to be much cheaper than those currently available in the market. Even the five-litre table-top bioreactor, available at our laboratory, can produce 5 grams of protective antigen per litre per day. This is enough to manufacture one million doses. The company is setting up a much larger capacity. The economy of scale will further drive down the price.

**Dream 2047:** We are curious to know what made you – you as well as Dr. Yogendra Singh – to work on anthrax vaccine.

**Prof. Bhatnagar:** Both of us commenced our work on anthrax when we were in a U.S. laboratory several years ago. I was actually working on the molecular mode of action of the anthrax toxin. What prompted us to work on anthrax even after returning to India was outbreak of an anthrax epidemic in West Bengal in 1994. Subsequently, we submitted a proposal to develop an anthrax vaccine to the Department of Biotechnology and this was approved in 1995.

This July, our team at the Centre for Biotechnology submitted a paper on the vaccine to the American Society for Cell Biology and it was accepted for a conference in Washington on December 8-12, 2001. The ASCB, in the aftermath of anthrax scare in the U.S., released the findings to the public through its website [www.ascb.org](http://www.ascb.org) in October itself, and requested me to address a press conference during the meeting.

**Dream 2047:** What do you feel about this achievement?

**Prof. Bhatnagar:** First of all we are very happy that we could achieve what we had set out for. Moreover, it is often said that quality scientific work is difficult in India. The appreciation our work received from the peers – both in India and abroad – shows that quality work can be done in India, provided there is a conducive environment. We are certain that this could not have been achieved without unwavering support that we received from the Department of Biotechnology, an excellent environment that exists in Jawaharlal Nehru University and above all the consistent effort of students who work in our laboratory.

\* T.V. Jayan has recently joined Vigyan Prasar as a Fellow.

## Towards an environmentally sound society

□ Dilip M. Salwi

**D**r. Salim Ali Chowk is a location in Mumbai named after that bird-watcher extraordinary. And the reason why the chowk is so named is also obvious. Here stands the 'Hornbill' building of the Bombay Natural History Society with the logo of the hornbill bird, which has today become almost synonymous with that birdwatcher. This large Non-Governmental Organisation is the pioneer of environmental movement in the sub-continent. It aims to identify, monitor and mitigate the adverse impact of unplanned, non-sustainable development processes on our natural environment. Even before the Independence of India, in 1933, the society's Curator S.H. Prater highlighted the problems of protecting wildlife in the country. It has played a key role in not only saving the Silent Valley, banning the export of frogs, preventing the creation of a highway through Sanjay Gandhi National Park, Mumbai, etc., but it has also been associated with the stipulation of the Wildlife Protection Acts in the country.

The society's mission is actually the late Dr. Salim Ali's life-long passion: "Conservation of nature, primarily biological diversity, through action based on research, education and public awareness". Today, it spearheads the environmental movement by setting up research stations, conducting research programmes, maintaining collections of flora and fauna, assisting researchers, publishing magazine, journal, monographs and books, organizing environmental education and awareness programmes. It has recently set up the BNHS Conservation Education Centre in Mumbai to popularize environment and its conservation among the people who matter and children.

"Environment conservation became a profession only in the 70s," said Dr. A.R. Rehmani, a leading ornithologist and the present Director of the society, giving its more than a century long history "Earlier, conservation was done by the barrel of the gun under the British Raj!" The society was set up as early as in 1883 by eight persons who had interest in the natural history of the sub-continent. A wide variety of specimens of birds and animals was collected and preserved in the society's office. Today, the society maintains those specimens, some even of extinct birds and animals, along with others collected over a century. To date, the society houses collections of 26,000 birds, 20,000 mammals, 7,500 reptiles and amphibians, and 50,000

insects, which have today become a part of the National Heritage of India.

Over the years, the society has been conducting research on various aspects of environment, ecology, flora and fauna specific to India. At present, more than 20 projects are in progress in different parts of the country. "Our research studies have led to several recommendations," said Issac Kehimkar, the soft spoken Public Relations Officer of the society and an expert on wild flowers "For instance, our study traced the bird hazards to aircraft in Mumbai to slaughterhouses in Devnar and made certain recommendations to reduce the bird menace. Our ten year study on elephants in Mudumalai sanctuary, Tamil Nadu, has led to the discovery of their migratory

routes. Recommendations to respect those routes have been made to the concerned department. In fact, we're building a baseline data for the Project Elephant which is likely to be started in the country soon".

Today, under the sponsorship of several national and international bodies, ministries, forest departments, industries and institutes, about 20 projects on as diverse subjects as ecology of some rare raptors, biological diversity of mangroves, status and distribution of vultures, survey of marine turtles, and ecology and status of hispid hare, etc., are in different stages of progress. The society's research stations at Bharatpur, Rajasthan, and Point Calimere, Tamil Nadu, have also generated multidisciplinary data on wetland and coastline ecosystem respectively for the first time in the country. Besides, the society has an

Environmental Impact Assessment Cell meant to conduct studies on certain environmentally and ecologically sensitive areas for guiding policy and development planners in the Government and industry. Since 1993, the society has been organizing the Salim Ali Bird Count programme which intends to create a countrywide network of birdwatchers. During last year, 195 persons participated in the programme and collected information on 331 species of birds from 87 sites in 15 states!

The 95-volume-old Journal of Bombay Natural History Society being brought by BNHS, has today become the most prestigious publication on natural history in this part of the world. It publishes research and field studies and surveys conducted by leading names in environment and



The Hornbill building of the Bombay Natural History Society at Dr. Salim Ali Chowk.

ecology. Hornbill, the multi-colour quarterly magazine of the society, introduces the flora and fauna in a semi-popular style to its readers. Besides, the society has brought out several authoritative monographs and books on birds, mammals, insects, wild flowers, etc, in collaboration with some leading publishers. The most popular among these books are Salim Ali's internationally recognised books on birds, namely; *The Book of Indian Birds*, *Pictorial Guide to*



Preserved bird specimens in the BNHS collection.

*the Birds of the Indian Subcontinent, and Handbook of the Birds of India and Pakistan (10 volumes). Encyclopedia of Indian Natural History*, Edited by R.E. Hawkins, which was brought out on the occasion of the centenary celebrations of the society, is also a valuable guide to natural history of the country. To increase its corpus fund, the society also brings out regularly attractive greeting cards, calenders, T-shirts and caps with the message of environment conservation.

Today, the Ministry of Environment and Forests has recognised the society as the Regional Nodal Agency to coordinate the network of wildlife research in the western region of the country. Since 1957, the society has been affiliated to the University of Bombay as a Post Graduate Department in field studies in zoology and botany. It has some seats for M.Sc. in both zoology and botany. Ph.D. studies in these fields are also regularly conducted under the able guidance of the staff. In recent years, the society has also started various courses which are the need of the hour, yet not offered by any university. For instance, the society offers one year leadership course in biodiversity conservation for any person above 18 years of age. It also offers a one year correspondence course in basic entomology. The library of the society containing 20,000 books, 120 theses and 5,000 bound volumes, including century-old books, is also the largest, authentic and upto-date source of information for any student or researcher of natural history.

Environmental education and awareness is the need of the hour. Not only school and college students in cities, towns and villages need to be sensitized about the importance of environment and its conservation but also villagers, bureaucrats and policy-makers. "The society has

been imparting environment education and awareness very actively since 1993," said Kehimkar. "In fact, Salim Ali Natural Conservation Fund has been set up to spread environmental awareness". In addition to organising nature camps, treks, etc, in wild places, the society has also established the BNHS Conservation Education Centre in 33 acres of land adjacent to the Sanjay Gandhi National Park in Goregoan, Mumbai. The Centre has an auditorium,



Preserved animal specimens in the BNHS collection.

five nature trails, display and discovery room which introduce nature to about 10,000 students every year in a wide variety of ways, such as games, puzzles, displays, video and slide shows, and even first hand visits to the neighbouring jungles. It also has a mobile van equipped with audio-visual shows which goes from village to village to spread environmental awareness. Seminars and workshops are also conducted at the Centre to sensitize corporate groups, bureaucrats and army officers to conservation issues, so that they go back to their offices with the commitment for an environmentally sound development in the country.

In its last more than a century of existence, the society and its members have received world wide recognition. The society has received the first Indira Gandhi Paryavaran Puraskar in 1987 and the UNEP's Global 500 Award 1990. Its former illustrious President, Dr. Salim Ali, had received several national and international awards and honours. The present Honorary Secretary, Dr. J.C. Daniel, has also received several accolades for his contributions. With more than 5,000 members in 30 countries, one would not come across any environmentalist of repute in India who has not been actively associated with the society one time or the other in his or her life. As Dr. Salim Ali says "constant dripping of water wears out even stones", the slow and steady yet concrete work of the society will go a long way in producing an environmentally sound India in the time to come.

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## Recent Developments in Science and Technology

### Carbon Shows Magnetism at Room Temperature

Metal-free organic magnets were first discovered 10 years ago, but their magnetic properties were disappearing at temperatures only slightly above absolute zero. Now in a discovery made quite by accident, researchers have found the first example of an organic magnet that perseveres at higher temperatures.

Tatiana Makarova of the Ioffe Physico-Technical Institute in Russia and colleagues were searching for superconductivity in a polymer of fullerene—a cage-like molecule comprised of 60 carbon atoms—they realized that their product demonstrated magnetic qualities at room temperature. The magnetization in some of the samples, the scientists write, was strong enough for them to be lifted off a table surface by a small magnet. The researchers suggest that the high-pressure, high-temperature processes required to create the polymer form of  $C_{60}$  results in a magnetically ordered state, although they are not sure exactly how this happens.

Attempts are going on in the direction to find out the reasons and it is sure that the result will represent a break through in the magnetism of metal free materials.

*Nature, November 2001*

### Researchers Create Nonmagnetic Magnet

Magnets, by definition, produce magnetic fields, but it is not necessarily, says a team of Japanese physicists in the September 17th issue of Physical Review Letters. Hiromichi Adachi of High Energy Accelerator Research Organization in Tsukuba, Japan, and colleagues created a magnetic alloy that under certain conditions lacks magnetism.

In ordinary magnets, both individual electron spins and the motion of electrons in their atomic orbitals generate magnetic fields. Combined, these fields produce the material's total magnetic field. In some rare-earth elements, though, the two contributions are nearly identical. With that in mind, Adachi's group created an alloy from aluminum and samarium, a rare-earth element having opposite spin and orbital moments that vary with temperature.

They found that at temperatures just above and below 70 degrees Kelvin, they could readily magnetize the  $SmAl_2$  alloy using an external magnetic field. But at precisely 70 degrees Kelvin, the spin and orbital moments in the material cancelled each other out. The alloy won't find uses on refrigerators or as compass needles, but the scientists suggest it may have applications in spintronics—a new class of electronic devices that harness electron spins instead of charge.

*Scientific American, Sept 2001*

### Scientists Grow Heart Cells from Embryonic Stem Cells

U.S. researchers at the Technion-Israel Institute of Technology announced that they have successfully turned embryonic stem cell cells into the heart cells. Their results appear in the August issue of the Journal of Clinical Investigation.

The scientists started with a line of embryonic stem cells and first grew a mass of undifferentiated cells. They then moved the cells into a suspension containing growth factors designed

to encourage differentiated growth. While dividing, the stem cells consolidated into so-called embryoid bodies, or microscopic clumps of cells. The researchers noticed that approximately 10 percent of these bodies contained cells that were spontaneously contracting—a signature of cells called cardiomyocytes that develop into heart tissue in an embryo.

To test whether what they had created were in fact cardiomyocytes, the researchers ran a variety of tests. They analyzed the electrical and chemical activities of the cells, examined their structure with an electron microscope, investigated their responses to hormones such as adrenaline, and probed the genes and proteins within the cells. Comparing the results to known cardiomyocytes suggested that they had successfully cultured the cells.

*Scientific American 2 November 2001*

Compiled by : Kapil Tripathi

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### Letter to the Editor

In September 2001 issue of "Dream 2047", Shri Ranatosh Chakrabarti has written a nice article on Radha Gobinda Chandra. In fact, Shri Chakrabarti is one of those pioneers who first brought the works of Shri R.G. Chandra into limelight from the back-seat of oblivion in the early years of 1980's. In this regard I would like to add a few more points about Shri Chandra.

It has been rightly stated by Shri Chakrabarti that Shri Chandra was one of the early observers of Nova Aquilae 3, but he was very late in communicating his findings to Europe or America. A picture taken from Harvard Observatory on 7 June, 1918 showed this Nova as an object of +6 magnitude whereas on 9 June, 1918, the brightness of the Nova reached its maximum (magnitude -0.5) outshining all other stars except Sirius and Capella. But Shri Chandra failed to realise the significance of his observation and merely observed the rise and fall of brightness of the Nova Aquilae 3 with great pleasure. Later, when he communicated to Shri Jagadananda Roy, science teacher of Santiniketan, about his Nova observation, Shri Roy advised Shri Chandra to write a letter to famous astronomer E.C. Pickering of Harvard Observatory describing his findings. Shri Chandra delayed further in sending a letter and ultimately when his letter reached Mr. Pickering five months later, it was too late. In the meantime an European scientist Mr. Bower achieved the honour of being the first person to communicate his observational findings of Nova Aquilae 3 on June 8, 1918. But as a mark of recognition and respect to the findings of this self-taught astronomer of a remote village of British India, Mr. Pickering wrote a letter to Shri Chandra and presented him some books on astronomy. Afterwards Mr. Pickering offered Shri Chandra honorary membership of 'American Association of Variable Star Observers' (ASVSO).

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I just wish to convey to you that if possible, will you please specify in the Dream 2047 issues that "Information from Dream 2047 may be reproduced with due mention of relevant details and a copy to Dream 2047"? This will help regional language newspaper to get latest science news, particularly papers with spread of one or two districts.

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