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Monthly Newsletter of Vigyan Prasar

DREAM 2047

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VP News

Eastern Regional VIPNET meeting, Bhubaneshwar

A three day Eastern Regional VIPNET meeting was held during Nov 13-15, 2002 at Srujanika, Bhubaneshwar, with a view to promote VIPNET initiatives in the Eastern States, *viz,* Bihar, Jharkand, Orrisa and West Bengal. Sixty eight participants from Bihar (14), Jharkand (8), West Bengal (10), Orissa (36) participated in the meeting.

The meeting had a twin purpose of providing an exposition to various types of science communication activities that can be undertaken by the VIPNET clubs and also provide a forum for leading VIPNET clubs and activists to express their expectations from Vigyan Prasar. Dr T V Venkateswaran, from Vigyan Prasar, Dr Nikhil Mohan Pattnaik, Ms Pushpashree Pattnaik, Jeeban Kumar Panda, Sh. Subhendu conducted various technical sessions. The highlight of the programme was that an Oriya version of *VIPNET News* was released in the regional meeting.

Sessions on Fun-Science, Nature study, Night sky watching, hydroponics, use of puppetry for science communication were organised. Science fun introduced the participants to key ideas like what is science, role of activities in communicating science and types of activities that can be taken up in the clubs without much material requirement. In the sky corner discussions were held on the basics of sky watching and of celestial movements. The nature study involved number of activities like measuring the height of tree, drawing the canopy of the tree, taking bark and leaf prints, identification of tree, preparation of leaf figures. Nature walk and sample collection were integral to the nature study activity.

Demonstrations on Ham radio and use of WorldSpace Radio for science communication were also conducted. Ms Anamica Das from Bharath Scouts and Guides conducted the Ham Radio demonstrations. An exhibition of Popular Science books published by Vigyan Prasar and other organizations was arranged.

The regional meeting also provided a forum for various groups associated with VIPNET to share their experience and expertise. A detailed demonstration of hydroponics was made by the resource persons from Nature Society, Bihar. Ms Saritha Anand, Red Rose Society, Jharkand presented a small skit using puppetry by way of demonstration of how puppets can be used in communication of scientific ideas. Paschim Banga Vigyan Manch and Bihar Bharath Gyan Vigyan Samithi exhibited popular science books published by their respective organizations. Dr T V Venkateswaran delivered a talk on Venus transit. All the participants agreed to initiate and intensify the formation of VIPNET science clubs in their region. A field trip was arranged to Chilka Lake, Zoological and Botanical garden and Planetarium. ❒

DREAM-2047 wishes its readers a happy and prosperous New Year

Inside

EDITORIAL

Shri M.V. Kamath, President of the Vigyan Prasar Society has taken over as Chairman, Prasar Bharati. Our hearty congratulations to him.

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

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CMYK

A New Year Resolution

The year 2002 posed numerous challenges before us in the form of droughts in several parts of the country, resurgence of polio, ever increasing number of aids victims, and acute shortage of drinking water in many parts of the country. But there were events and achievements that also brought cheers. Centre for Biomedical Engineering, IIT(Delhi), developed a male injectable contraceptive RISUG (Reversible Inhibition of Sperm Under Guidance), International Crop Research Institute for Semi-arid Tropics developed the first ever transgenic peanut in the world, ISRO launched the first exclusive 1060 kg meteorological satellite (METSAT) from the Sriharikota Space Centre using PSLV, and discovery of the huge natural gas find 'Dhirubhai' in Andhra Pradesh (named after the late Dhirubhai Ambani) by Reliance, were only some of the outstanding achievements that brought cheers and instilled a sense of pride in us. Yet another great news was that a renowned scientist became the President of India.

If there was one event in the year gone by that generated high excitement in the Capital, it was the metro rail beginning its run with a flying start. The city could not have asked for a better Christmas gift traversing eight kilometers in about twenty minutes, though travelling at a modest speed of 50 kmph. Using normal modes of transportation, it could take nearly one and a half hours! Indeed, it stands out as an outstanding example of high level international cooperation between India, Japan and South Korea, and the Delhi Government. More than a million thronged – probably out of excitement - to the stations seeking tickets to ride on its air conditioned Korean built coaches. However, the opening of the metro was marked by chaos, confusion and vandalisation. Passengers broke windows, uprooted handles, scratched interior of the coaches, and even relieved themselves at the metro stations. It was expected to be a prized possession and pride of the Capital and viewed as a system that could bring some cheer to the commuters harassed by traffic jams and pollution.

I always held a belief – if we give something to the people they would feel proud of, they would preserve it and would take utmost pains to maintain it. I am referring to the Kolkata metro which became a part of its transportation system nearly a decade and a half ago. Kolkatans still maintain it with love and care. Why was then Delhi metro defiled and defaced? Does rapid urbanization fail to even instill the basic sense of civic responsibility, or at times even bring out the worst in the human beings to the fore? May be, yes. But, then how is it that even the pilgrimage places or the national monuments are not spared from being defaced? Why can we simply not admire the eternal beauty and the serene environs of the Taj Mahal or the India Gate? Why must public places or offices be littered with junk and paan juice? Why must a garden be littered with ice-cream cups or used paper plates after the picnickers have left?

The contempt with which we treat public property is amazing indeed. In contrast, in Western countries, citizens handle the public property and spaces with care and respect. Be it a national monument, a children's park, a museum, a bus, or a suburban train – it is never treated with the contempt we come across in our country. In fact, they even pick up the litter left behind by others - if any!

This also leads us to the contempt with which we treat our beautiful lakes, rivers, trees, forests, birds, animals, wildlife, mountains, air and land. We often come across cases when meat of a black buck or a bird belonging to an endangered species is served to a group of revellers, or the beautiful rocks and hills are defaced, or the rivers are turned into drains. Is this not vandalizing our beautiful flora, fauna and other natural resources? It is imperative that we learnt to identify ourselves with nature, and conserved it with love and care.

Let us refrain from vandalizing the public property. Let us refrain from vandalizing the nature. Let us pick up more litter than we leave behind. Let this be the resolution for the New Year. To achieve this, we shall need to transform ourselves first, and set an example to our fellow citizens. Charity begins at home. Delhi metro will then continue to run on its track and will become a prized possession to feel proud of, to be loved and cared for.

❒ **Vinay. B. Kamble**

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Satyendra Nath Bose

The Creator of Quantum Statistics

Subodh Mahanti

Who doth ambition shun,
And loves to live i' the sun,
Seeking the food he eats
And pleas'd with what he gets,

Shakespeare in *As You Like It*

The main human lesson drawn from investigation of natural phenomena ever more remote from ordinary experience is the recognition of the inseparability of objective knowledge from our ability to put questions to nature by means of experiments suited to give unambiguous answers.

Niels Bohr

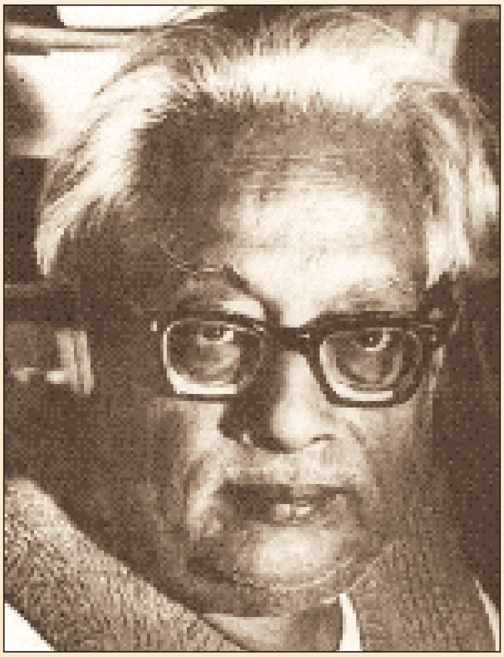
Never accept an idea as long as you, yourself, are not satisfied with its consistency and logical structure on which the concepts are based. Study the Masters. These are the people who had made significant contributions to the subject. Lesser authorities clearly bypass the difficult points.

Satyendra Nath Bose

Perhaps Satyen Bose's greatest charm lies in his ability to look at life in a total manner. The minor pleasure of leisure and pleasant company were to him a part of a bigger universe of the pleasures of the mind and the intellect. In a sense this was also his strongest limitation. Bose was a man who tried to see the world around him in its entirety, in its complexity and in which his particular science and himself were small parts.

B. D. Nag Chaudhuri

Satyendra Nath Bose along with Meghnad Saha, established modern theoretical physics in India. Bose made significant advances in statistical mechanics and quantum statistics, the description of all forces by a single field theory, X-ray diffraction and the interaction of electromagnetic waves with the ionosphere. In 1924 Bose derived Planck's blackbody radiation law without the use of classical electrodynamics as Max Karl Ernst Ludwig Planck (1854-1947) himself had done. Albert Einstein's generalization of Bose's work led to the system of statistical quantum mechanics, now known as Bose-Einstein Statistics which describes particles of integral spin, which may multiply occupy the same quantum state. Such particles are now known as "bosons" after the name of S. N. Bose. Bose's name has become part and parcel of modern physics. There is no other scientist whose name is so indissolubly linked with Einstein in all the textbooks of physics. 'Indeed Bose's work stands out as one of the central columns supporting the edifice of modern physics'. As Partha Ghose has stated, "Bose's work stood at the transition between the `old quantum theory' of Planck, Bohr and Einstein and the new quantum mechanics of Schrodinger, Heisenberg, Born, Dirac and others."



S.N. Bose

Bose was a rare combination of kaleidoscopic versatility and evergreen vivacity. He made two important contributions in mathematical physics one in his 20s and the other in his fifties. In terms of number of publications (if we go by the present trend where every scientist would tend to flaunt his number of publications rather than their contents) his contribution would appear to be hopelessly insignificant. He published only twenty-five papers including the obituary note on Einstein published in *Science and Culture*. Out of these 25 papers 17 were single authored that is by Bose himself. He had certainly the ability to do more important work in mathematical physics. But he did not do. Why? Bose alone could have answered that. However, it does not mean that in the intervening thirty years (1924-1953) he did not do anything. He worked in as diverse fields as chemistry, mineralogy, biology, soil science, philosophy, archaeology, the fine arts, literature and languages.

Unfortunately in India Bose's name is not so familiar. This is a reflection of sad state of Indian science. To quote G. Venkataraman: "The name of Satyendra Nath Bose will live for ever in physics…Unfortunately, most people in India have never heard of him. I would not be surprised if most of our scientists also do not know much about him, although they might have heard his name. Indeed, I am prepared to bet that barring a sprinkling of physicists (mostly theorists), many in our physics community too are ignorant about Bose. Even if they have heard of him, it is quite likely that they are not aware of the significance of his work."

Satyendra Nath Bose (or S. N. Bose, as he is mostly known) was born on January 1, 1894 in Kolkata (then Calcutta). His ancestral home was in the village Bara Jagulia in Nadia district. In the late 18th century, when Kolkata was yet to emerge as a metropolitan city, Nadia used to be the centre of cultural and intellectual activities in Bengal. The dialect of Nadia was adopted as standard form of Bengali language. He was the eldest and only son of his parents, Surendranath Bose and Amodini Bose. Bose had six sisters. His father, Surendranath worked in Railways. Bose's grandfather Ambika Charan also held a government job. Bose started his primary school education in the Normal School, which was close to their home. Incidentally this was the same school where Rabindranath Tagore spent a short period. As the family moved to their own house in a different location Bose's school also changed. This time he was admitted in the New Indian School. He was again shifted to another school, the Hindu School. The mathematics teacher of the Hindu School, Upendra Bakshi, was a legendary figure. Once Bakshi gave Bose 110 marks out of hundred in a test examination. It was certainly a crazy behaviour because you do not expect to get more marks than the specified maximum marks allotted to a particular subject. So the headmaster asked for an explanation. The unrepentant teacher replied: "Satyen had succeeded in the allotted time in correctly solving all the questions without excluding any of the alternatives." He passed the Entrance Examination from the Hindu School in 1909. In fact he stayed one year more in the Hindu School as he was due to sit for the entrance examination in 1908. But just two days before the examination he contracted chicken pox and so he could not appear for the examination. Bose utilized the time by studying advanced mathematics and Sanskrit classics.

Albert Eisntein

After passing the Entrance Examination he joined the intermediate science course at the Presidency College of Kolkata. Here his teachers included Prafulla Chandra Ray (1861-1942) and Jagadish Chandra Bose (1858-1957) . He passed his Intermediate Examination in 1911. It is interesting to note that he had physiology as his fourth subject in ISc examination and in which he scored 100 marks out of hundred. In the BSc Honours examination in Mathematics, which he passed in 1913, he stood first in order of merit. He passed the MSc examination in mixed mathematics (modern-day equivalent to applied mathematics or mathematical physics). He not only stood first in the examination but also created a new record in the history of the Calcutta University by securing ninety-two percent marks. Meghnad Saha stood second in both the examinations. Bose, and also Saha, joined the newly created University College of Science as lecturer. Their first appointments were in the Department of Applied Mathematics but after a year they got themselves transferred to the Department of Physics. On their initial teaching assignments Bose said: "We took upon ourselves the teaching of postgraduate students. Saha taught Theory of Heat and Thermodynamics and Spectroscopy in the Physics Department and Hydrostatics in the Mathematics Department. I was more amphibious, teaching both Physics and Applied Mathematics quite regularly. On me fell the task of teaching General Physics and giving all entrants suitable introduction to Mathematical Physics, teaching them Differential equations, Harmonic analysis etc. I also taught Elasticity and Relativity in the Mathematics Department."

Erwin Schrodinger

Besides teaching, both Bose and Saha started doing research. They did not have any laboratory facility. The only thing they had was the library of the Presidency College. Even there the advanced books by the great masters were not available. Fortunately for Bose and Saha one Dr. Bruhl in the Bengal Engineering College had many important books and they started borrowing from him. Dr. Bruhl belonged to Austria. On health ground he was advised to live in a country with a warmer climate. That is how Dr. Bruhl landed at Kolkata. Dr. Bruhl, who was trained as botanist, taught engineering physics and run the laboratory in the Bengal Engineering College.

Max Planck

Bose's first important contribution in theoretical physics was a joint research paper with Saha. The paper titled "On the influence of the finite volume of molecules on the equation of state", was published in the *Philosophical Magazine* in 1918. The next year Bose published two papers in the *Bulletin of the Calcutta Mathematical Society*. One was on "The Stress Equation of Equilibrium" and the other "On Horpolhod". Both these papers were on pure mathematics. In 1920 he again published a joint paper with Saha on the equation of state in the *Philosophical Magazine*. This was followed by Bose's paper "On the deduction of Rydberg's law from the quantum theory of spectral emission" in 1920. This was also published in *Philosophical Magazine.* Then there was no publication from Bose for three years.

When the Dhaka University was founded in 1921, Bose moved there as Reader in the Department of Physics. In a letter written to his friend M. N. Saha, Bose described the situation at the Dacca University: "…It has been well over a month since I moved to your part of the country. Work has not yet started. Your Dacca College had quite a few things but due to utter neglect they are in a bad way. Perhaps I need not elaborate. On the table of the *Sahibs* are scattered lots of Nicol prisms, lens and eye-pieces. It would require a lot of research to determine which one belongs to which apparatus. We do suffer from lack of journals here, but the authorities of the new university have promised to place order for some of them alonwith their back numbers. Talk is going on about having a separate science library."

Werner Heisenberg

While teaching post-graduate students at the Dhaka University Bose felt dissatisfied with the existing derivations of Plank's Radiation Law. Inspired by discussion with Saha, Bose developed a logically satisfactory derivation based entirely on

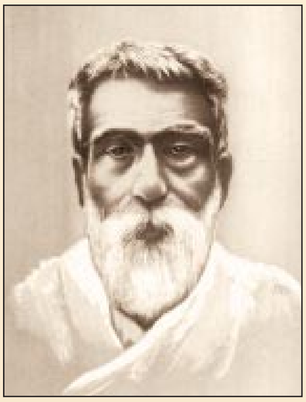
Einstein's photon concept. As in earlier cases he sent his paper to the *Philosophical Magazine* but to his disappointment this time his paper was turned down. Then he decided to send the paper to Albert Einstein with a request to arrange its publication in *Zeitschrift für Physic*. It was a bold decision. Bose's letter to Einstein has become important document in the history of science. Bose in his letter dated June 04, 1924 wrote:

"I have ventured to send you the accompanying article for your perusal and opinion. I am anxious to know what you think of it. You will see that I have tried to deduce the coefficient $8\pi v^2/c^3$ in Plank's Law independent of classical electrodynamics, only assuming that the elementary regions in the phase-space has the content h^3. I do not know sufficient German to translate the paper. If you think the paper worth publication I shall be grateful if you arrange for its publication in *Zeitschrift für Physic*. Though a complete stranger to you, I do not feel any hesitation in making such a request. Because we are all your pupils though profiting only by your teachings through your writings. I do not know whether you still remember that somebody from Calcutta asked your permission to translate your papers on Relativity in English. You acceded to the request. The book has since published. I was the one who translated your paper on Generalised Relativity."

Max Born

Einstein not only acknowledged the receipt of Bose's letter but also assured Bose that he would have it published as he regarded it as an important contribution. Einstein himself translated Bose's paper into German and it was published in August 1924 issue of *Zeitschrift für Physic* under the heading "Plancksgesetz Lichtquantenhypothese" (Its English title was "Planck's Law and Light Quantum Hypothesis") with the following comment of the translator: "Bose's derivative of Plank's formula appears to me to be an important step forward. The method used here gives also the quantum theory of an ideal gas, as I shall show elsewhere." This is how quantum statistics was born. It may be noted here that statistical ideas entered physics through the work of James Clerk Maxwell (1831-79) and Ludwig Eduard Boltzmann (1844-1906) on the kinetic theory of gases, more than a century ago.

Einstein applied Bose's method to give the theory of the ideal quantum gas, and predicted the phenomenon of Bose-Einstein condensation.



P.C. Ray

When Bose was trying to rederive Planck's Law he himself was not even aware that he would make a revolutionary discovery. Planck's Law had been known for well over twenty years and there were a number of derivations including the one by Einstein. Bose said to J.C. Mehra, who wrote about Bose in 'Biographical Memoirs of Fellows of the Royal Society of London': "I had no idea that what I had done was really novel. I thought that perhaps it was the way of looking at the thing. I was not a statistician to the extent of really knowing that I was doing something, which was really different from what Boltzmann would have done from Boltzmann statistics. Instead of thinking of the light quantum just as a particle, I talked about these states. Somehow, this was the same question that Einstein asked when I met him. How had I arrived at this method of deriving Plank's formula? Well, I recognized the contradictions in the attempts of Planck and Einstein, and applied the statistics in my own way, but I did not think that it was different from Boltzmann's statistics." It may be noted that even Einstein could not foresee the full potential and application possibilities of Bose's idea, which, along with its subsequent development by Fermi provided the basis of categorizing the fundamental particles into two groups –bosons after Bose and fermions after Fermi.

Paul Edrien Maurice Dirac

In early 1924 Bose applied for two years leave from the Dhaka University to enable him to go to Europe to familarise himself with latest developments in his fields. He got the permission only after he could show Einstein's appreciative postcard to the Vice Chancellor of the University. Thus Bose in one of his letters to Einstein wrote: "Your first postcard came at a critical moment and it has more than any other made this sojourn to Europe possible for me."

Bose arrived in Europe in October 1924. He intended to spend a few weeks in Paris before going to Berlin to meet Einstein. He was more comfortable in French than in German. However, he ended up in staying about a year in Paris. Explaining this Bose said to Mehra: "I wanted to go abroad directly to Berlin but I did not venture to go straight on because I was not sure of my knowledge of German. I came out thinking that perhaps after a few weeks in Paris I should be able to go to Berlin to see Einstein. However two things happened:

i) Friends

ii) Letter of introduction to Langevin

My friends, who received me on arrival there, took me to their boarding house, where they were staying. Then they all insisted that I should stay there. Well I found it convenient to be among friends."

After reaching Paris he wrote to Einstein requesting his permission to work with him and also for his opinion on his second paper. Bose wrote:

"My heartfelt gratitude for taking trouble of translating the paper yourself and publishing it. I just saw it in print before I left India. I have also sent the middle of June a second paper entitled, 'Thermal equilibrium in Radiation Field in the presence of Matter.'

I am rather anxious to know your opinion about it, as I think it to be rather important. I don't know whether it will be possible also to have this paper published in *Zeitschrift für Physic.*

I have been granted leave by my university for 2 years. I have arrived just a week ago in Paris. I don't know whether it will be possible for me to work under you in Germany. I shall be glad, however, if you will grant me permission to work under you, for it will mean for me the realization of a long-cherished dream…"

While Einstein did not acknowledge the receipt of Bose's second paper but this time Einstein replied. In his letter to Bose dated November 03, 1924, Einstein wrote: "Thank you sincerely for your letter of 26 October. I am glad that I shall have the opportunity soon of making your personal acquaintance. Your papers have already appeared sometime ago. Unfortunately the reprints have been sent to me instead of you. You may have them at any time. I am not in agreement with your basic principle concerning the probability of interaction between radiation and matter, and have given the reasons in a remark which has appeared together with your paper…We may discuss this together in detail when you come here." Bose was naturally disappointed by Einstein's comments on his second paper. However, he started thinking deeply about the objections raised by Einstein. He informed Einstein that he was attempting to answer Einstein's criticism in the form of a paper. In fact Bose had shown the manuscript to Paul Langevin (1872-1946) in Paris, who thought it worth publishing. However, the paper was never published.

J.C. Bose

At Paris, one of his friends, Prabodh Chandra Bagchi, introduced Bose to Sylvian Levi, the well-known French Indologist, who in turn gave Bose a letter of introduction to Paul Langevin. Bose wanted to familarise himself with latest developments in theoretical as well as experimental physics. Accordingly Bose thought that he should learn radioactivity techniques from Marie Curie (1867-1934) and something of X-ray spectroscopy from Maurice de Broglie (1892-1967). Langevin, who suggested that Bose should pursue the possibility of working in Curie's laboratory, gave him a letter of introduction to Curie. Accordingly Bose met Curie. Although Curie recognised Bose's genius but at the beginning she was hesitant in admitting him in her laboratory as she was not sure Bose's knowledge in French. This was because of earlier unhappy experience with an Indian student, who had no knowledge in French. So she had given Bose a long lecture emphasising the importance of knowing French. So after spending few months in learning French Bose returned to Curie's laboratory and where he made certain difficult measurements of piezoelectric effect. However, Bose's desire to learn techniques in radioactivity remained unfulfilled. Though Bose had a good working knowledge in French but he did not tell the same to Curie at their first meeting. If he informed Curie about his knowledge of French she would have accepted him as her research assistant. Throughout his life Bose never tried to draw attention to himself. Those who did not understand Bose's nature explained it in other ways. For example William A. Blampied thought that 'Bose was terribly intimidated by most Europeans.' To support such conclusion Blampied cited the following instances: "Although he (Bose) was in Paris with Langevin while the latter was communicating with Einstein on de Broglie's thesis, there is no evidence that Bose ever tried to impress upon Langevin his dream of working with Einstein. Presumably Madame Curie would have accepted him as research assistant had he been able to convince her that he knew sufficient French. Yet he was either too polite or too frightened to interrupt he English monologue by replying in French and thus (perhaps) convincing her."

Ludwig Eduard Boltzmann

Meghnad Saha

With a letter of introduction from Langevin, Bose met Broglie, who readily allowed Bose to work with his chief assistant, Alexander Dauvillier. At Broglie's laboratory Bose not only learnt diverse techniques of crystallography but also became interested in theoretical aspects of crystal behaviour.

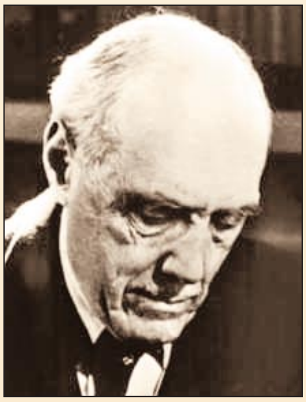
In October 1925 that is after spending about a year, Bose proceeded to Berlin. He was anxious to meet Einstein. But he had to wait several weeks before he could meet Einstein, who was on his annual visit to Leyden. Bose did not work with Einstein but his meeting with him was quite profitable. Einstein's letter of introduction enabled him to borrow books from the University Library and attend the physics colloquium. With Einstein's help he could meet some of the topmost German scientists—Fritz Haber (1868-1934), Otto Hahn (1879-1968), Lise Meitner (1878-1968), Walther Bothe (1891-1957), Michael Polanyi, Max von Laue (1879-1960), Walter Gordon(1893-1940), Paul Eugene Wigner(1902-) and others. He worked in X-ray crystallography in Polanyi's laboratory and got engaged in theoretical studies with Gordon. He also frequently visited 'Radioactivity' laboratory of Hahn and Meitner. Bose visited Gottingen and where he met Max Born (1882-1970) and Erich Huckel (1896-1980).

James Clerk Maxwell

In the latter half of 1926 Bose returned to Dhaka. Though he stayed nearly two years in Europe Bose did not publish anything. His friends suggested that he should apply for the


Paul Langevin

post of Professor in the Physics Department of the Dhaka University. They also suggested that he should get a letter of recommendation from Einstein. Einstein was little surprised at the request because he thought Bose should naturally get the appointment. But he complied with the request. Apparently Einstein's recommendation letter did not help Bose. The post was offered to D. M. Bose. However, when D. M. Bose declined the offer Bose was appointed as Professor and Head of the Department of Physics in 1927. At Dhaka he got engaged in experimental physics. He initiated studies on crystal structures. Perhaps such studies were undertaken for the first time in the country. He took up the task of designing his own experimental equipment. He designed and constructed X-ray diffraction cameras for rotation and powder photography. He formulated a simple method for identifying the indices of the plane of reflection of Laue photographs recorded in cylindrical camera. He had a fascination for chemistry. So he started doing research in organic chemistry. He studied the reactions of p-acetyle-amino-benzene-sulphonazide with pyridine and he also worked on the synthesis of some pyrone derivatives related to Patulin. In his chemistry related work he was assisted by P. K. Dutta. In 1938 Bose investigated the problem of total reflection of radio waves in the ionosphere. It is said that it was M. N. Saha who induced Bose to look into this problem. To quote one of Bose's colleagues Dr. Satish Ranjan Khastgir: "Prof. Saha had once come to Dacca from Allahabad. He gave a lecture in the Physics Department. He addressed a huge gathering at the Curzon Hall. Saha spoke these problems relating to reflection of radio waves from the ionosphere on which he was working. He asked his friend Bose to work out a solution for an intricate problem like this. Appleton had given three conditions for the reflection of radio waves, Saha introduced a fourth one based on the hypotheses that there is no absorption of radio waves in the ionosphere. But Saha knew himself that the assumption was arbitrary. So he requested Prof. Bose in the open meeting to give a general solution to the reflection problem. After this lecture Satyendra Nath concentrated on the problem and finally succeeded in finding a general solution."


Louis Victor de Broglie

Bose returned to Kolkata in 1945 to become the Khaira Professor of Physics in Calcutta University. During 1953-54 Bose published five important papers on the Unified Field Theory. Although these papers were quite important but they did not create a great stir as earlier papers in 1924. He sent these papers to Einstein. Einstein was not sure how precisely Bose's solution was to be used in physics and he discussed it in detail in one of his papers. Bose wrote down his reply in detail and he was supposed to discuss it personally with Einstein at Bonn on the occasion of the celebration of the 50th anniversary of the discovery of the theory of relativity. It did not happen. Einstein died in 1955. When Bose came to know the death of his master (as Bose addressed Einstein in his letters to Einstein) he was so overwhelmed with grief that he tore and threw away the only copy of his important paper. And that was the end of his work on the unified field theory,

He had set up a laboratory of Organic Chemistry at the Department of Pure Physics at the University College of Science. A group of research students under Bose's leadership initiated an extensive study of Indian clay minerals by X-rays, chemical analysis and cation exchange technique. He also tried to synthesise emetine and quinine but was forestalled by other foreign scientists. He initiated a systematic search for germanium in Indian sulphide minerals. Dr. Asima Chatterjee, a well-known Indian chemist, who worked with Bose on the structure and stereochemistry of several alkaloids and other inorganic substances, said: "Work on inorganic complex salts and clay minerals was another major contribution of Professor Bose. A large number of samples of clays, shale and soil from different parts of India were studied. X-ray diffraction methods and the differential thermal analysis were employed in order to understand the atomic structure of common clay minerals and the effect of the layer thickness upon cation exchange. Since clays are poor reflectors of X-rays, there is a tendency to choose small diameter cameras but in general with small cameras important details of the power diagram may not be resolved. As such, an adjustable flat-plate camera was designed and used in this investigation. The differential thermal analyzer used in the present investigation was constructed after the design of Berkelheimer.


Marie Curi

Very little work was done in India at the time when this project was undertaken. As clays were formed under widely varying environmental conditions the study of minerals from regions still unexplored is important both for the purpose of verification and for new information. With this object in view a differential thermal analyzer and a micro-focus X-ray tube were designed at the laboratory for the study of a number of Indian clays obtained from a wide variety of sources and isolated from different types of soils."


Otto Hahn

In 1956 Bose became the Vice Chancellor of the Visva Bharati University at Shantiniketan founded by Rabindranath

Tagore. Bose was to start teaching of science. He was also to initiate scientific research in the newly created University. It may be noted here Tagore had dedicated his book *Visva Parichay* (Introduction to the World of Science) to Bose. However, Bose was not welcomed by the old-timers at Shantiniketan. Perhaps they thought that Bose's initiative would go against the established tradition of Visva Bharati. Whatever might be the reasons for their disliking towards Bose's presence at Shantiniketan, Bose was quite disappointed and returned to Kolkata in 1958. It was in 1958 that he was elected Fellow of the Royal Society of London. Bose should habe been elected long back. In 1959 he was appointed as National Professor, a post he held till his death

Lise Meitner

To most of the smaller minds, Bose represents an image of a genius—which disliked hard work and wasted his energies in trivialities. This is because Bose took almost thirty years after the publication of the paper in 1924, which made him internationally known to publish another important paper. But then physics was not the only thing for Bose. Bose's range of interests was unlimited. Bacon had said: "I have taken all knowledge to be my province." This was equally true for Bose, though he himself might not have declared it. In this context it is important to quote what B. M. Udgaonkar had to say about Bose: "For smaller minds he had become a drop-out. However, his keen, perspicuous and versatile mind, trained in the method of physics and mathematics was allowing itself to range over a variety of fields, including chemistry and biology, soil science and mineralogy, philosophy and archaeology, fine arts, literature and music. Then after thirty years, during 1953-55, at the age of sixty he performed a tour de force and published some important papers in Unified Field Theory, showing that his mathematical powers were still as keen as ever."

Erich Huckel

Bose was an unconventional scientist. He detested any form of formal dress. He would not even mind attending an international scientific conference wearing a lungi around him. He was totally informal. Anybody could enter his room just by pushing the door. An interesting episode depicting Bose's informal nature has been described by Shantimay and Enakshi Chatterjee: "Professor P. A. M. Dirac had come to Calcutta along with his wife in the mid-fifties. They were sharing the same car with Bose. Bose let them have the back seat. The front seat, which Bose occupied along with the driver, did not have much room; nevertheless Bose asked some of his students to get in. Dirac, a little surprised, asked if it wasn't too crowded. Bose looked back and said in his disarming fashion, `We believe in Bose statistics,' Dirac explained to his wife, `In Bose statistics things crowded together.' But surprisingly enough Bose preferred not to talk of his work except by way of joke." Bose mostly worked out his calculations on loose sheets of paper and he did not bother to preserve them.

Bose was averse to anything that would publicise his name. He did not attempt to get a PhD degree and so while doing path-breaking work in science he remained a plain MSc. He enjoyed all good things in life.

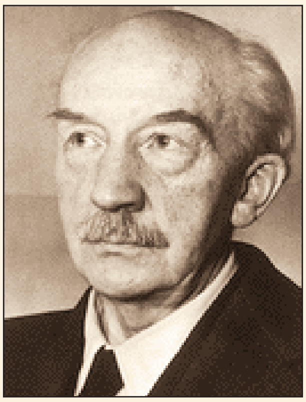
Max von Laue

In meetings, conferences or in any public forums Bose would often close his eyes and people would think that he had fallen asleep. But he used to be alert all the time. To quote S. D. Chatterjee, who wrote about Bose in *Biographical Memoirs of the Fellows of Indian National Science Academy*: "The conscious and the unconscious appeared to have a strange deep unity in his restless brain. At different level of perception the legend curved out a superb figure of a giant who was engagingly childlike and a man of supreme genius who was entirely human. Often he appeared to be immersed in laziness, but the somnolescence was full of alertness. Once presiding over a lecture of Professor Niels Bohr at the Saha institute of Nuclear Physics, he had closed his eyes and it seemed that he was asleep. But when Professor Bohr hesitated before the blackboard and said 'Perhaps professor Bose can help me here', he at once opened his eyes, explained the mathematical point and seemed to revert to his unseeing meditation. On another occasion, at the same venue, he was presiding over a lecture by Professor Frederic Joliot Curie. After introducing the speaker in English, he closed his eyes as usual. But when Professor Joliot asked for an interpreter to render his speech in French into English and none came forward, Professor Bose opened his eyes, stood up and translated Professor Joliot's speech into chaste English sentence by sentence."

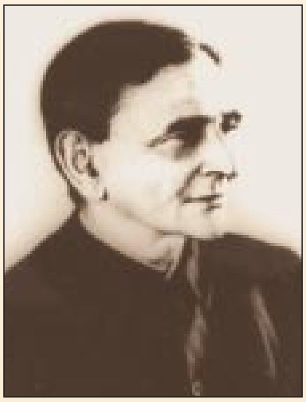
Fritz Haber

Bose loved music and fine arts. Commenting on Bose's love for fine arts and music, S. D. Chatterjee wrote: "His (Bose's) personality casts its spell of genius on the common people. They regarded him as a living myth or legend. Often in informal musical concerts, Bose, the connoisseur of classical music, would close his eyes and seem to fall asleep, to everybody's dismay. But at the end, he would open his eyes and put extremely pertinent questions to the performer. He was extremely fond of instrumental music and played on the *Esraj* like a master. People have seen him playing on his *Esraj* in a lonely corner of his home, with tears rolling down his eyes.

He also had an absorbing interest in fine arts, and often discuss about the elegance of mural paintings with maestros like Jamini Roy. Seldom did he decline to attend any musical soitree, cultural function or art exhibition, when invited."

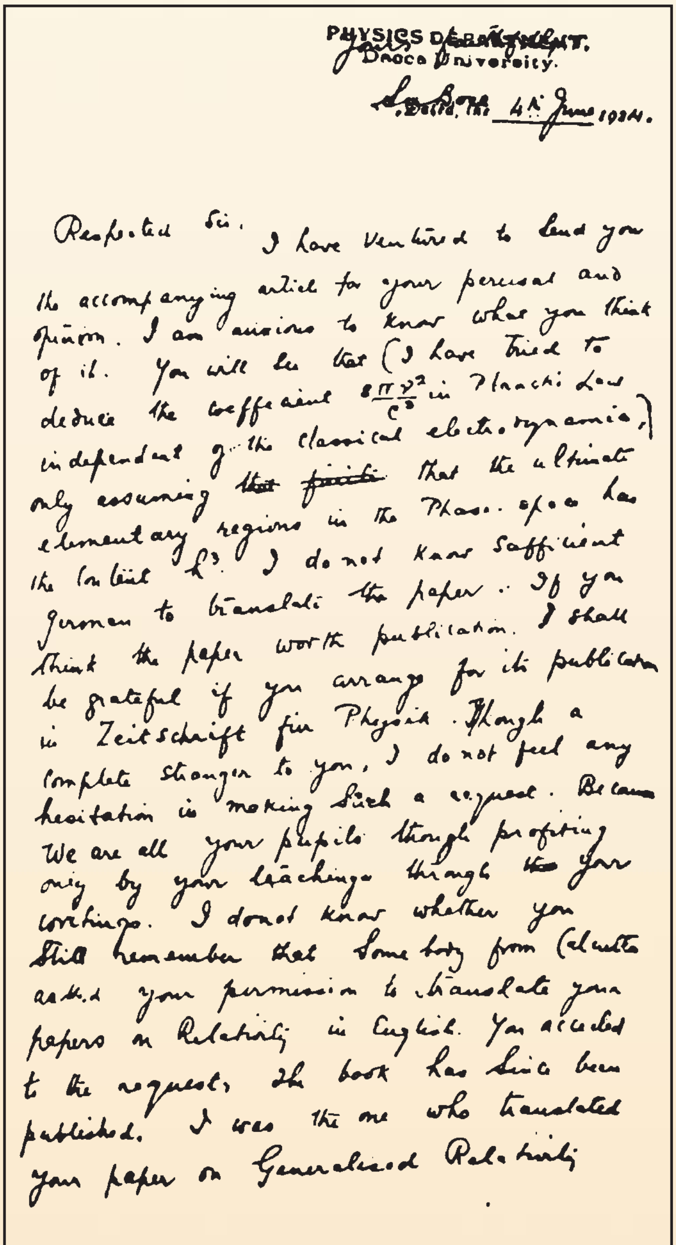

Walther Bothe

Further Shantimay and Enakshi Chatterjee have written that Bose played the flute too. They wrote: " The fact that he played the *Esraj* himself is well known. What is not so well known is that he played the flute too. Music was one of his early loves and his interests ranged from folk music to classical as well from Indian to Western. When Professor Dhurjati Prasad Mukherjee was writing his book on Indian music he received a number of helpful suggestions from his friend Bose. Dhurjati Prasad used to say that if Bose had not been a scientist he might have become a master musicologist."


D.M. Bose

Bose was a great populariser of science. He strongly felt that it was the duty of a scientist to present science to the common man in his own language. For popularizing science Bose wrote in Bengali. This is the reason why his contribution in popularizing science is not known outside Bengal. It were largely Bose's efforts which led to the establishment of the *Bangiya Bijnan Parishad* (Science Association of Bengal), a registered society with the sole objective of promoting and popularizing science through the vernacular. The *Parishad* was formally inaugurated on January 25, 1948. The circular announcing the formation of the *Parishad* stated: "We need science at every step, but our system of education does not prepare us for it, so that we are not able to utilize science in our everyday life. The main obstacle so far was a foreign language through which education was being imparted. Today the ties have changed. New hopes and aspiration are emerging. Now it is the duty and the responsibility of our scientists to popularize science through the medium of our scientists to popularize science through the medium of vernacular and thus help to create a healthy scientific attitude among the people. As a first step to this effort it has been resolved to form a `Bangiya Bijnan Parishad'. It was mainly through the inspired leadership of Professor Satyendra Nath Bose." The *Parishad* started a monthly magazine on popular science in Bengali, *Jnan O Bijnan* (Knowledge and Science). As part of his attempt in popularizing science through the vernacular Bose even started teaching


Frederic Joliot Curie


PHYSICS DEPARTMENT.
Dacca University.
Dated, the 4th June 1924.

Respected Sir, I have ventured to send you the accompanying article for your perusal and opinion. I am anxious to know what you think of it. You will see that I have tried to deduce the coefficient $\frac{8\pi\nu^2}{c^3}$ in Planck's Law independent of the classical electrodynamics, only assuming that the ultimate elementary regions in the Phase-space has the content h^3. I do not know sufficient German to translate the paper. If you think the paper worth publication I shall be grateful if you arrange for its publication in Zeitschrift für Physik. Though a complete stranger to you, I do not feel any hesitation in making such a request. Because we are all your pupils though profiting only by your teachings through the your writings. I do not know whether you still remember that somebody from Calcutta asked your permission to translate your papers on Relativity in English. You acceded to the request. The book has since been published. I was the one who translated your paper on Generalized Relativity.

Bose's historic letter to Albert Einstein

Relativity to post-graduate students in colloquial Bengali.

Bose died on February 04, 1974. As S. D. Chatterjee has written, "With Professor Satyen Bose's death an era ended—an era of great men who created science in India." Bose was too precious for India. India has many scientists but number of really great scientists is very few. In the Centenary Edition of *Chambers Biographical Dictionary* (1997), which has entries of over 17,500 detailed biographies, only the names of six scientists figure namely J. C. Bose. C. V. Raman, S. Ramanujan,

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Cobwebs are not just muck

T V Venkateswaran

The ultimate dream for any sophisticated, self-respecting security personal could one day be a light, but tough bullet-proof vest and most likely it would be made out of spider-silk! Material scientists are currently unravelling the secrets of *Nephila clavipes*, the golden orb-weaving spider, in their search for a new breed of eco-friendly superfibres that could satisfy as diverse products as fire- and bullet-resistant clothing, parachute straps, sports racquets and aircraft components. These advanced and sophisticated products require materials that are light at the same time strong for ease of use.

Today, we use artificial fibres, such as Kevlar and Spectra, derived from petrochemicals, for manufacture of these products. While on the one hand the raw material is becoming scarce day by day, as petrochemical sources are fast drying up on the other hand waste and pollution results from the processing causing ecological damage to our environment, has inspired researchers to look for eco-friendly alternative materials. In this exertion what else could be our best guide, than Nature?

> Dragline silk comes into its own when toughness is key: although less energy is needed to break a silk thread than high-tenacity Kevlar yarn, dragline silk is far more extendible. This stretchiness allows it to adsorb an unsurpassed amount of energy before its threads snap apart — just the thing to stop bullets in their tracks, or to make climbing gear safer.

Material scientists were wonderstruck to note that the cobwebs spun by spiders (arachnids) are really tougher and more elastic, than even silk. Spider radial webs, technically called, ‘Dragline’ silk, seems to be an good substitute to Kevlar and other artificial fibers because they are recyclable and produced at ambient temperature and pressure. Actually, weight-for-weight dragline silk is stronger than steel and more resilient than any synthetic polymer fibre, despite being finer than a human hair it is about five times stronger than steel and twice as strong as Kevlar of the same weight. Thought only one-tenth the width of a human hair dragline silk can stop a bee traveling at about 60 kmph without breaking. Spider silk also has the ability to stretch about 30-percent longer than its original length without breaking, which makes it very resilient. In other words, in the movie, Spiderman drastically underestimated the strength of real dragline silk, actually it would not need to be nearly as thick as the strands deployed by our web-swinging hero in the movie at all!

Composition of Dragline silk

Spider silk consists of long protein molecules- chains of amino acids. Dragline silk is a composite material comprised of two different proteins, glycine and alanine, each containing three types of regions with distinct properties. One of these forms an amorphous (noncrystalline) matrix that is stretchable, giving the silk elasticity. When an insect strikes the web, the stretching of the matrix enables the web to absorb the kinetic energy of the insect’s flight. Embedded in the amorphous portions of both proteins are two kinds of crystalline regions that toughen the silk. Although both kinds of crystalline regions are tightly pleated and resist stretching, one of them is rigid. It is thought that the pleats of the less rigid crystalline regions not only fit into the pleats in the rigid crystals but that they also interact with the amorphous areas in the proteins, thus anchoring the rigid crystals to the matrix. The resulting composite is strong, tough, and yet elastic. Synthetic fibres such as Kevlar’s structure are also similar: crystalline regions are embedded in a rubbery, amorphous matrix. But for obtaining this structure and the desired properties artificially, it requires spinning long polymer chains at high temperatures and pressures using strongly acidic organic solvents. Whereas, spiders spin their webs in ambient temperature and pressure, making it eminently suitable as an eco-friendly product.

The secret of spiders’ spinning ease is ‘dope’, the starting material from which spiders spin their fibres. This dope is a liquid-crystalline solution, like normal liquids, liquid-crystalline solutions can flow freely, so they needn’t be pressed through the small orifices used to form synthetic fibres. The dope moves through the insect’s continuously narrowing spinning organ, and the web is spun. However the protein molecules which can move freely in the liquid-crystalline solution, are aligned with each other along the axis of the developing fibre. This small trick provides its extra strength. We all know that it is rather difficult to break a stick by pulling apart as compared to breaking it by bending and pulling. As the protein molecules are aligned with one another, they are akin to sticks placed along side one another and this alignment adds extra strength.

Spinning the web

Humankind has attempted to mimic many aspects of nature’s design principles, from Velcro to solar cells, but a process as complex as spider silk spinning has never yet been replicated. While spiders can be coaxed to make silk, attempts to create “spider farms” have failed because of the territorial nature of the arachnids.

One attempt has been to sequence the genes coding for spider silk. By sequencing the genes scientists are trying to seek ways of modifying the spider silk in such a way that they retain its essential properties but enhance or modify where they require change. For example, spider silk is very strong, but exposure to water turns it into a rubbery mess and, that makes it a very unstable materials for practical use.

Researchers have successfully produced spider silk proteins in bacteria and yeast in the past, however these have not been successful for extraction of spider webs. Alternatively, some scientists are exploiting anatomical similarities between spider silk glands and mammalian glands. Bio-tech companies such as Nexia Biotechnologies, Inc. in Montreal, Canada, are developing genetically modified goats whose milk contains dissolved spider silk proteins. They are now trying to work out whether the proteins are in their natural state, and how they might be extracted and concentrated easily. Once the relationship between protein compositions, the structure of the resultant silk thread and how the structure controls the thread’s mechanical properties is understood, silk production could be tailored to specific applications. ❐

Two Faces of Medicines – A Closer Look

P.C. Samantaray

Higher margins of profit, good returns on investment, commercial viability etc. are no longer recognised as success in medicines/Allied products' business. The parameters of real success are the extent to which such products sold in the market, reduce the community burden of Morbidity & Mortality due to target diseases and improve the quality of life. Drug industry as also government therefore have a compulsive obligation of community welfare, while striving for growth and survival.

The eternal cycle "Health – Ill Health – Health" is perpetuated by 3 factors e.g. Agent, Host and Environment. Ultimately the susceptible population present with Acute, Sub-acute and Chronic diseases which need prescriptions for medicines. Broad Categories of medicines available in the market are Curative (primary therapy/bacterial and parasitic infections), Suppressive (for symptoms of diseases) and Preventive (specific medicines/immunity). Each medicine requires to be well formulated (G.M.P/G.L.P.), bio – equivalence tested with competing brands, clinically evaluated, data supplied for doctor's information, available in required dosage forms, easy to use (by patients), nicely packed with essential instructions to users, within shelf-life, available in chemists shops and reasonably priced. A birds eye view of Medicines market (India) reveals: total number of therapeutic Groups (Body system wise) – 15, basic Pharmacologically active agents – 200, total no. of brands available in home market – 12,00 No. of active PSU/National/ MNC/SSI Companies – 750 and gross value of home pharma annual market turnover Rs. 15,000/- crores.

The main parties involved in the process of ensuring the consumer of a safe and effective medication are the manufacturer of he durg (the company), official (DCG/State DCs) drug regulatory agencies, the intermediate traders or wholesalers, the hospital, primary health care centers or other health care institutions and their staff, the dispensing pharmacist of drug retailers, the prescribing doctors and the patients.

Consuming medicines has become unavoidable in all age groups. Starting with preventive vaccines and a host of branded products bearing claims of promoting normal growth in infants and toddlers, the community consumes host of medicines throughout life. Because of liberal commercial promotion by producers, most of the medicines are acquired by patients directly from the retail outlets based on their previous experience of the products and more often that not, on the advice of those who don't know details about such products. Such tendency is on the increase because of several reasons, the most important being :

(a) Seeking quick remedy
(b) Saving the expenditure on consultation, investigation and rational/specific prescription by competent doctors.
(c) Fear of being forced into hospitalization.

The resultant effect is that, sizeable volume of medicines are sold in the market as OTC (Over The Counter) purchase.

Because of multiplicity of provider agencies, rational use medicines assumes paramount importance. Otherwise, the population is always exposed to a host of adverse reactions because of a number of factors like Drug interactions and limitations in usage of medicines in special situations like Liver Diseases, Renal Diseases, Pregnancy, Breast Feeding, Elderly and Children.

The purpose of drug related information usually supplied along with each pack as product information insert, is not just to deliver a message, but to effect change in knowledge, attitude and eventually behavior while using medicines. The value of such communication is to be judged not on contents, but on its effect on the recipient (patients). Communication therefore must be matched to the knowledge, social background, level of literacy, interest, purposes and needs of the patients. Words must have the same meaning for the makers, the prescribes as also the users of medicines. To assess whether such communication has succeeded, feed-back, both immediate and subsequent is essential, which unfortunately receives no public attention.

Rational use of drugs therefore demands: no Self Medication, no Suggestions to/from friends, not repeating medication for same illness merely on the basis of some past experience, considering special situations while using medicines and destruction of all left-over medicines at home, as soon as they are no more necessary.

Nevertheless, we all know, that medicines can also do harm to users, swinging from relatively insignificant hangover following use it a hypnotic or anti-histamic preparation to sudden death following a single injection of penicillin, fatal blood of death as a consequence of prolonged use of highly effective medicines for bronchial asthma and rheumatoid arthritis. Whereas, doctors must be judicious while prescribing medicines, patients too on their part should use them strictly as per advice of doctors. Factors promoting non-compliance include the patient's personality and education level, social isolation, the king of medicine, the number of medicines being taken concurrently, frequency of administration, duration of treatment, whether the patient feels ill of quite well (e.g. moderate high blood pressure). Apart from that, in all developing countries, other systems of medicines are being increasingly adopted by people and the respective government. This greatly adds to the potential risks of poly-pharmacy. We already know that conventional allopathic drugs used together do interact within body and thereby jeopardize therapeutic objectives of individual drugs.

Further, having obtained the medicines, some 3% to 50% of patients do not take it at all, or if they do so, do not accurately follow the prescriber's instructions; on depressed out-patients the rate of non-compliance or non-adherence can can be as high as 70%. Antibiotics should be used only on a doctor's prescription, because indiscriminate use promotes the spread of drug-resistant bacteria so that infections become untreatable or treatable only with the less safe drugs. In addition, some particularly serious bacterial infections, e.g. of the heart valves, are partially suppressed by delayed until fatal damage has been done by persisting infection.

Medicines for self-medication should generally be confined to symptoms where accurate diagnosis of cause is not required, for short-term relief of a symptom and where the margin of safety of the drugs used is substantial. It is high time the subject of Rational use of Drugs is understood by millions of users of medicines, because of which, there is unavoidable necessity of educating and involving the general population in the matters relating to safety of medicines. To start with, the proposal for formation of local medicine advisory committees, probably can be given serious thought. The functions of such committees inter-alia stress upon :

- Educating the general public so that they are empowered to choose their option.
- Advising practicing doctors, hospital staff as well as pharmaceutical industry to educate the general public on proper use of medicines.
- Right of the patients to know all that is necessary to avoid adverse reactions because of medicines, they use.

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Lobachevsky and His Geometry

Utpal Mukhopadhyay

After publication of 'Elements' by Euclid (ca. 330 B.C.-275 B.C.) for nearly two thousand years Euclidean geometry monopolized the field of geometry. Euclidean geometry is flawless and it is the last word on geometry – this was the opinion of mathematicians. But, ultimately Euclidean geometry lost its omnipotency and in spite of vehement opposition from most of the mathematicians, non-Euclidean geometry emerged as an alternative approach to geometry. Nikolai Ivanovich Lobachevsky (1792-1856) was one of those who were instrumental in the birth and development of non-Euclidean geometry.

Lobachevsky was born on 1 December (20 November according to Julian Calendar) 1792 in Gorky of Russia. His father was an employer of small earnings. His mother had tremendous contributions for nourishment of hidden talent of Nikolai and his two brothers. Their mother was very energetic and judicious lady so that in spite of financial stringency of her family she sent all her three sons to Kazan Grammar School. Nikolai studied in that school during 1802-1807 and from 1807 to 1811 in Kazan University. He was very strong in mathematics and after successfully completing graduation, he joined the Kazan University for teaching in 1816.

Nikolai Ivanovich Lobachevsky

As a teacher, Lobachevsky was very successful. Due to his lucid and comprehensive presentation of various topics, his method of teaching deeply influenced his students. His range of knowledge was so vast that besides mathematics, he delivered lectures on mechanics, astronomy, geodesy and topology. In 1827, Lobachevsky was appointed as a 'Rector' of Kazan University and remained in that post for twenty years. Being a talented and enthusiastic administrator, within a short period he developed Kazan University as an ideal educational institution for higher studies. Due to his effort, a journal named 'Scientific Proceedings' started publishing on behalf of University. Although he was an able administrator, yet it is his mathematical contributions that have made him immortal.On 23 February, 1826 Lobachevsky for the first time presented his research paper on non-Euclidean geometry in the departmental meeting of 'Physico-mathematical Sciences' of Kazan University. This paper was published in the journal 'Kazan Herald' in 1929 and 1930 with the title 'On the Fundamentals of Geometry'. Almost all of the contemporary mathematicians of Russia and abroad, without realising the real significance of his new theory, started vehemently opposing Lobachevsky. Even his students showed antagonistic attitude towards him. But Lobachevsky was unruffled by this opposition and went on publishing papers on non-Euclidean geometry. His last paper was published a few days before his demise and during the, preparation of this paper he had to take recourse of others help as, by then, he lost his sight. While Lobachevsky dictated the paper, his helper put it down in black and white. Apart from geometry, he made fundamental contributions in algebra and calculus as well. Lobachevsky developed a nice method for finding the approximate solution of an algebraic equation. In 1846, he was relieved of his duties at Kazan University and was appointed as an assistant trustee of Kazan Educational District. He breathed his last on 24 February, 1856. In 1896, forty years after his death a monument was erected in his memory at Kazan.

Crisis in non-Euclidean geometry and emergence of non-Euclidean geometry

'Elements' of Euclid contains more than four hundred fifty theorems based on five axioms and five postulates. The crisis in Euclidean geometry started with its fifth axiom which states that – "If a straight line falling on two straight lines makes interior angles on the same side less than two right angles, the two straight lines, if produced indefinitely, meet on that side on which the angles are less than two right angles". Since, this postulate is different from the others, many mathematicians thought that it was nothing but a theorem. For this reason, many attempts had been made to prove this postulate as a theorem during next two thousand years after Euclid. Famous mathematicians such as Posidonius (1st Century B.C.), Ptolemy (85-168), Proclus (410-485), Nasir Eddin (1201-1274), J. Wallis (1616-1703), J.H. Lambert (1728-1777), A.M. Legendre (1752-1833), F. Bolyai (1775-1856) presented many proofs of fifth postulate. But careful observation revealed that all those proofs were either based on defective argument or depended on such a postulate that was nothing but a modified form of Euclid's fifth postulate. In history of mathematics, very few problems received so much attention of mathematicians and they have not toiled so much for any other problem as the fifth postulate. However, it is interesting to note that three mathematicians, almost simultaneously, in trying to prove Euclid's fifth postulate, discovered non-Euclidean geometry. Those three mathematicians are Lobachevsky, Janos Bloyai (1802-1860) and Karl Friedrich Gauss (1777-1855).

Carl Friedrich Gauss

In order to have an idea about non-Euclidean geometry, one has to know the meaning of 'geodesic'. Geodesic is the shortest distance between two points on a surface. Geodesic plays the same role in non-Euclidean geometry as that of a line segment in case of a plane (i.e. Euclidean surface). Rejecting the common belief that fifth postulate of Euclid is indispensable for a consistent geometry, Lobachevsky developed a new type of geometry without that postulate. He suggested that at least two lines can be drawn parallel to a line through a point situated on the same plane outside that line. The non-Euclidean geometry discovered by Lobachevsky. Bolyai and Gauss was named as 'Hyperbolic Geometry' by

Felix Klein (1849-1925). On the other hand, the non-Euclidean geometry discovered by Bernhard Riemann (1826-1866) was named by Klein as Elliptical Geometry. Various features of hyperbolic geometry are as follows :

(1) More than one line parallel to a particular line (geodesy) can be drawn through a point.
(2) Sum of the angles of a triangle is less than two right angles.
(3) Two lines perpendicular to a particular line are neither parallel nor intersecting. For instance, in Fig. 1, AC and BD are equal and both of them are perpendicular to CD.
(4) Area of a triangle is proportional to the amount by which it is less than two right angles, i.e. the larger the difference between two right angles and the sum of angles of a triangle, the great will be its area. For instance, in Fig. 2, the sum of the angles of the triangle A'B'C' is less than that of the triangle ABC, but the area of the triangle A'B'C' is greater than the area of the triangle ABC.

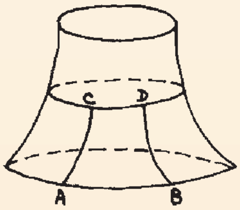


Fig-1

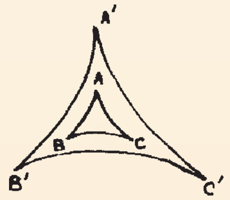


Fig-2

Non-Euclidean geometry of Lobachevsky, Bolyai and Gauss will be applicable for surfaces like the surface near the neck of a pitcher (Fig. 3). On the other hand, non-Euclidean geometry developed by Riemann is fit for surfaces like the inflated portion of a pitcher.

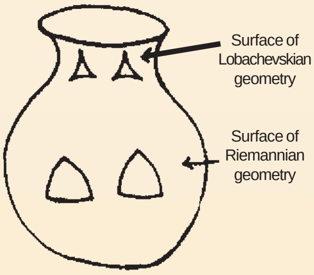


Fig-3

Development of non-Euclidean geometry

During the period of thirty years after the discovery of hyperbolic geometry of Lobachevsky, very few mathematicians paid attention to it because most probably others failed to realize the impact of non-Euclidean geometry in the field of mathematics. The ignorance of them about newly discovered geometry was so much that in funeral ceremony of Lobachevsky, where usually discussions are made on virtuous works of the deceased person, none of the speakers uttered a single word about non-Euclidean geometry – the greatest work of his life. At last in 1868 when E. Beltrami (1835-1900) showed that hyperbolic and spherical (elliptical) geometry can be regarded respectively as geodesics of surfaces of negative and positive curvature, it was only then the importance of non-Euclidean geometry was realized. Afterwards, famous mathematicians like Felix Klein, Arthur Cayley (1821-1895), David Hilbert (1862-1943) further developed non-Euclidean geometry. At present important applications of non-Euclidean geometry have been made in Cosmology.

Hyperbolic geometry of Lobachevsky liberated geometry from narrow structure of Euclidean geometry. It has been possible to make use of this geometry in the theory of definite integral and other branches of mathematics. Although Lobachevsky was ridiculed by his contemporaries for his theory of non-Euclidean geometry and didn't receive his due recognition, future world have paid a fitting tribute to him. For this reason, W. K. Clifford (1845-1879) named Lobachevsky as 'Copernicus of Geometry'. So long as human civilization exists, learned people of the entire world will remember Lobachevsky and his geometry.

References:

1. A.S. Smogorzhevsky : Lobachevskian Geometry; Mir Publichars, Moscow, 1892
2. Vladimirov, Mitskievich & Horsky : Space, Time, Gravitation; Mir Publichers, Moscow, 1987
3. Utpal Mukhopadhyay: Jyamitit – Sekal Theke Ekale; Jnan-O-Bijnan, November 1994. ❐

Contd. from page....24

S. N. Bose, M. N. Saha, and Homi J. Bhabha. In *Cambridge Dictionary of Scientists* (2002) this number is reduced to four, where J.C. Bose and H. J. Bhabha do not figure and in the *Dictionary of Scientists* of the Oxford University Press (1999) this number is five, where the name of Bhabha does not figure. So there are only four Indian scientists namely C. V. Raman, S. Ramanujan, S. N. Bose and M. N. Saha whose names figure in all the three publications mentioned above. Can we hope to add some few more names in these publications? Our younger generation has a lot to learn from the lives of our great scientists like S. N. Bose.

Today there is an institute at Kolkata named after Bose— the S. N. Bose National Centre for Basic Sciences.

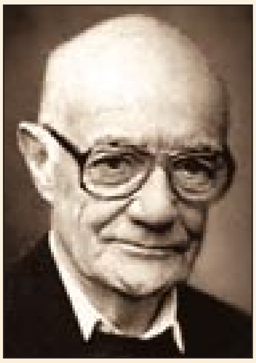
For Further Reading

1. Satyendra Nath Bose by Santimaya Chatterjee & Enakshi Chatterjee, National Book Trust, India, New Delhi, 1976.
2. The Unconventional Scientist by Santimay Chatterjee and Enakshi Chatterjee, *Science Reporter*, January 1994.
3. An Ingenious Derivation by Partha Ghose, *Science Reporter*, January 1994.
4. *Bose and His Statistics* by G. Venkataraman, Universities Press (India) Limited, Hyderabad, 1992.
5. *Satyendra Nath Bose* by S. D. Chatterjee in Biographical Memoirs of Fellows of the Indian National Science Academy (Vol.7), New Delhi, 1983.
6. Satyendra Nath Bose (1894-1974) by J. Mehra in *Biographical Memoirs of Fellows of the Royal Society (London)*, Vol.21, pp.118-154, 1975.
7. A World of Bose Particles by E.C.G. Sudarshan, *Science Today*, January 1974
8. The Crisis of Science by Satyendra Nath Bose, *Resonance*, February 1996 (this an English translation Bose's article published in Bengali in August 1931 issue of Parichay. The article is translated by Arnab Rai Chaudhuri)
9. Bose-Einstein Condensation Observed by Rajaram Nityananda, *Resonance*, February 1996.
10. *Some Eminent Indian Scientists* by Jagjit Singh, Publications Division, Government of India, 1965.
11. Prof. S. N. Bose: 70th Birthday Homage by Prof. S. N. Bose Seventieth Birthday Committee, Calcutta, 1964.
12. Bosons – The Birds That Flock and Sing Together by V.B. Kamble, Dream-2047, January 2002. ❐

Biological Macromolecules

Subodh Mahanti

The 2002 Nobel Prize in Chemistry was awarded "for the development of methods for identification and structure analyses of biological macromolecules" including proteins. One half of the prize was given jointly to ***John F. Fenn** (born 1917)* of Virginia Commonwealth University, Richmond, USA and ***Koichi Tanaka** (born 1959)* of Shimadzu Corp., Kyoto, Japan "for their development of soft description ionization methods for mass spectrometric analyses of biological macromolecules". The other half of the Prize went to ***Kurt Wuthrich** (born 1938)* of Swiss Federal Institute of Technology, Switzerland and the Scripps Research Institute, La Jolla, USA "for his development of nuclear magnetic resonance spectroscopy for determining the three dimensional structure of biological macromolecules in solution". That is how the Royal Sweidsh Academy of Sciences announced the Nobel Prize in Chemistry for 2002 on 9 October 2002. The new methods, as mentioned by the Nobel Committee, "have revolutionized the development of new pharmaceuticals." The laureates's research has "meant a revolutionary breakthrough, making chemical biology into the 'big science'". In each year Nobel Prizes are presented to the winners on December 10, the anniversary of Nobel's death in 1896



John F. Fenn

Koichi Tanaka

Kurt Wuthrich

Fenn , Tanaka and Wuthrich have contributed in different ways to the further development of two powerful analytical methods viz., ***Mass Spectrometry*** (MS) and ***Nuclear Magnetic Resonance*** (NMR), widely employed for structural determination of small and medium size molecules, to make them suitable to study biological macromolecules such as proteins. Because of their contributions it has now been possible to identify proteins in a given sample — rapidly and reliably. It has also been possible to produce a three dimensional (3D) image of a protein molecule in solution. In fact scientists can now both "see" the proteins and understand how they function in the cells.

Mass spectroscope (also called mass spectrograph or mass spectrometer), is an instrument used for determining the masses of atoms or molecules, in which a beam of ions is sent through a combination of electric and magnetic fields so arranged that the ions are deflected according to their masses. And the analytical technique used for identifying chemical structures, determination of mixture and quantitative elemental analysis based on application of mass spectroscope is called mass spectrometry. The foundation of the mass spectrometry was laid down by the end of the nineteenth century. A number of Nobel Prizes given in the 20^{th} century directly involved the application of mass spectrometry. For example the discovery of deuterium by Harold Urey, for which he was awarded Nobel Prize in Chemistry in 1934 and the discovery of fullerenes ("carbon footballs") by Sir Harold Kroto and Richard Smalley for which they were awarded Nobel Prize in chemistry in 1996. Mass spectrometry is a highly sensitive technique and it is being routinely used in doping and drug tests, foodstuff control and environmental analysis.

The first analyses of small molecules by using mass spectrometry was reported in 1912 by Joseph John Thompson. The attempt to adapt mass spectrometry to study biological macromolecules is not very recent. The desorption technology by which macro-molecules are transferred to ions in the gas phase was developed in this 1970s. This ushered in a revolution in this field during the last 25 years.

Macromolecules, though they are very large in compassion with other molecules but still they are quite small to be tackled for measurements. For example hemoglobin molecule, a large protein has a tenth of a thousand - millionth of a thousand-millionth of a gram (10^{-19} g). A protein molecules is identified by measuring its mass. To measures the mass o such a protein molecule, individual protein molecules are spread out as a cloud of freely hovering electrically charged protein ions. Once this is achieved the ions are accelerated in vacuum chamber where time of flight (TOF), that is the time taken by the ions to reach a target, is measured. The ions which reach the target at the earliest are those which have the highest charge. Fenn and Tanaka, who shared the half of the Nobel Prize, developed two methods for transforming protein molecules into the gas phase without losing their structure form.

Fenn developed a method called *electrospray ionization* (ESI) to produce small, charged, freely hovering ions of individual protein molecule. The release of such ions has been possible by spraying the sample using strong electric field to form charged droplets. When the water gradually evaporates from these droplets, what remain are freely moving "stark naked" protein molecules. As the molecules take on strong positive charges, the mass/charge ratio becomes small enough to be handled by ordinary mass spectrometers. The same molecule causes a series of peaks because each molecule can take up varying number of charges. Though at the first instance it may appear rather confusing but it gives additional information making the identification easier. The electrospray mass spectrometry, because of its speed and accuracy, is being widely used by drug companies.

Tanaka, for the first time, demonstrated the applicability of laser technology to biological macromolecules. It made possible to transform protein molecules into gas phase without loosing their structure and form. Tanaka showed that protein molecules could be ionized using ***soft laser desorption*** (SLD). In this technique a laser pulse is made to strike a protein sample in a solid or viscous phase. On taking up the energy from the laser pulse the sample is "blasted" into small bits so that the molecules are released. The individual molecules are released one after another as intact hovering molecular ions with low charge. These molecules are then accelerated by an electric field and detected as described above. Tanaka's discovery has led to the development of many of today's powerful laser desorption methods such as Matrix-Assisted Laser Desorption Ionisation (MALDI), Surface Enhanced Laser Desorption (SELDI), and Direct Ioniosation Silicon (DIOS).

The application of mass spectrometry tell us what kind and how much of a protein is present in a given sample. But NMR spectroscopy can show us how does the protein looks like. NMR is the absorption of electromagnetic or radio waves of a certain frequency by an atomic nucleus with non-zero magnetic moment in an external magnetic field. The atomic nucleus absorbs the radio wave through what is called its nuclear spin. This phenomenon was discovered in 1945 by Felix Bloch and Edward Purcell for which they were awarded the Nobel Prize in Physics in 1952. The frequency for nuclear resonance depends not only on the strength of the magnetic field and the type of atom but also on the chemical environment of the atom. The frequency at which an atomic nucleus say nucleus of hydrogen atom or proton absorbs depends on the magnetic field which that proton feels, and this effective field strength is not exactly same as the applied field strength. The effective field strength depends on the chemical environment of a particular proton. This means that at a given radiofrequency nuclei of hydrogen atoms in a given molecule absorb at the same effective field strength but they absorb at different applied field strengths. It is this applied field strength that is measured, and against which the absorption is plotted. The result is a spectrum showing many absorption peaks, whose relative positions reflect differences in environment of protons and thus gives detailed information about molecular structure.

A typical protein molecule though quite large, cannot be studied at sufficient resolution even by the most powerful microscope as it could not be weighed by conventional weigning machines however sensitive they could be. NMR spectroscopy can be used for this purpose. By studying the NMR spectrum of a molecule, its three dimensional picture can be drawn. Wuthrich's contribution has made it possible to use NMR spectroscopy for studying large molecules like proteins. Earlier it was successfully used for small molecules. Before Wuthrich's work it was extremely difficult to differentiate between the resonance of the different atomic nuclei in the NMR spectrum which may contain thousands of peaks. Wuthrich demonstrated how NMR spectrum could be used for resolving structure of a protein. He developed a systematic method of pairing each NMR signal with the right hydrogen nucleus (proton) in the macromolecules. This method, which is called ***sequential assignment***, has proved to be a cornerstone of all NMR structural investigations. Wuthrich showed that once the sequential assignment is done, it is possible to determine pair wise distances between a large number of hydrogen nuclei. This information then can be used with a mathematical method based on distance – geometry to calculate the three dimensional structure of the molecule.

NMR method for structural determination of protein developed by Wuthrich complements the X-ray crystallography method. It may be noted here that before the advent of NMR, X-ray crystallography was the only method available for determining the three-dimensional structure of protein. The first true three-dimensional structure of a protein, Myoglobin, was worked out by Max Perutz. This won him the Nobel Prize in Chemistry in 1962. The first complete determination of three-dimensional structure of a protein with Wuthrich's method was done in 1985. At present 15-20% of all the known protein structures (in thousands) have been determined with NMR. The NMR method determines the structure in solution and it shows the unstructured and very mobile parts o the molecule. Moreover physiological condition can be approximated as the proteins are studied in solution that is an environment similar to that in the living cells.

The techniques developed by Fenn, Tanaka and Wuthrich have led to a better understanding of the inner workings of the cell by analyzing proteins in detail. This has led to increased understanding of the process of life. Proteins are the cell's actors. They have helped determine protein structures and functions involved in the development of diseases such as cancer and malaria. In fact these techniques have revolutionized the development of new medicines. Many recent breakthroughs in drug discovery and design and new treatments for life-threatening diseases are based on the techniques developed by Fenn, Tanaka and Wuthrich. Promising applications are also being reorted in other areas. ❐

Letters to the Editor

I read "Dream 2047" for the first time and I was really impressed by the way it is put up. It will be good if we take less topics and give detailed information about them, this is the thing which impasses me the most. Its printing, in both English and Hindi should be continued. I read about Dr. A.P.J. Abdul Kalam and Marie Curie in the August and the September 2002 issues. It has been very beautifully presented.

Shipra Singh
Somerlle School,
Vasundhra Enclave Delhi-96

Dream 2047 has always been in an active mood. In our 'Child Science Forum' it is more popular than any other magazine published from Assam.

Sailen Kalita
Secy. Child Sc. Forum
Makhibaha Nallari, Assam

When I read the monthly news letter of Vigyan Prasar, it gave me a great pleasure. One must appreciate the same, as the DREAM is important for improving the knowledge in Science and Technology.

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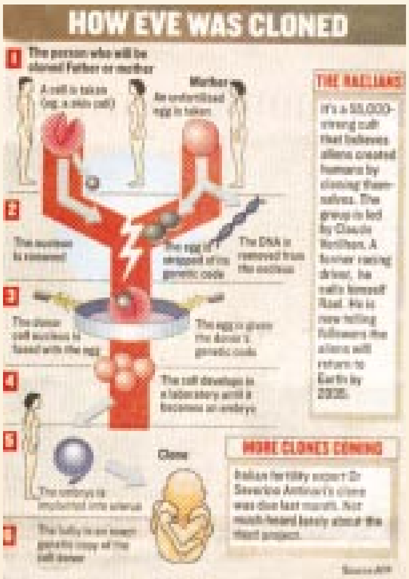
Recent Developments in Science and Technology

World's First Human Clone is Born, a Girl

French scientist Brigitte Boisselier made the announcement that First human baby was born through cloning on 26 December 2002. She is also a member of Raelian Sect. Members of this sect believes life on Earth was created by extra-terrestrials through genetic Engineering. In her announcement at Florida ,she said that 7 pound baby girl was doing fine and her parents were very happy but she did not offer any DNA proof to back the claim because according to her it was not immediately possible to obtained any independent scientific confirmation that the baby was in fact a clone. Till now she disclosed the identity of parents. She only told that baby's father are Americans and age of mother is 31 years.



If scientifically confirmed by independent sources, it would be the first human baby produced by the highly controversial technique-and announced publicly. It would also make the beginning of the new era in human reproduction-the first asexual birth, the first time a child was produced that was not the product of a genetic mix of mother and father but the identical reproduction of one of its parents In this case, Boisselier said the baby would be an identical twin of its mother. Cloning provides a genetic duplicate of another creature.

The predominant method around the world entails removing the nucleus or core from egg and replacing it with DNA from a donor. This DNA re-programmes the egg, transferring into it the entire genetic code of the donor. The big problem according to scientists, is to ensure that all genes in the transferred code work properly performing the dazzlingly complex business which is the making of tissue and repairing of it.

Increasing Data Storage Capacity

Using optical media made from common products researchers at Boston College's have discovered a new way to store nearly 20 times more data on disc that can be stored on standard DVD.

Their report, published in 'Nature Material' describes new fluorescent materials that are stable, inexpensive and able to store 3D data at high density. The storage media created by Boston college chemistry professor John Fourkas and colleagues work by using laser light to write a fluorescent spot at specific location in the material.

The data are written into the material by a process known as multi photon absorption and can be efficiently read out at relatively low laser intensities. The new fluorescents can be scanned repeatedly to readout the information – with little degradation seen after a million read cycles.

Source: Nature Material, December 2002

Scientists Discover New Adaptation to Oxygen-Poor Air at High Altitudes

Visitors to high-elevation locales often experience difficulty in breathing because the amount of oxygen available in the atmosphere decreases with increasing altitude. In extreme situations, altitude sickness can be fatal. But people born and raised at high altitudes function well despite the reduced availability of oxygen. New findings suggest that residents of a high-altitude village in Ethiopia have a unique way of adapting to the lower levels of oxygen at high elevations.

Previous researchers had suggested two ways that humans may adjust to lower oxygen levels. Both methods involve hemoglobin, a protein in red blood cells that binds to oxygen and carries it throughout the body. Members of a well-studied group living the Andes, for example, have more hemoglobin than people who live at sea level. Natives of the Tibetan plateau, in contrast, have similar hemoglobin levels as their low-living counterparts, but a greater percentage of the protein binds to oxygen molecules in the blood. Cynthia M. Beall of Case Western Reserve University and her colleagues studied 313 native residents of the Ambaras Region of the Semien Mountains National Park in Ethiopia, situated 3,530 meters above sea level. Surprisingly, the subjects not only had hemoglobin levels similar to those seen in sea level populations but they also displayed comparable rates of binding between oxygen and hemoglobin.

Source: Scientific American, December 2002

Proteins May Be Key to Pain Differences between Men and Women

When it comes to pain, men may be tougher than women because they have more of a particular type of protein, new research suggests. Two recent studies implicate proteins known as GIRKs in sex-based differences in pain sensitivity in mice. The findings could help researchers develop new gender-specific treatments for discomfort.

Previous research had shown that males tend to have a higher threshold for pain than females do and that medications affect the sexes differently, although the precise mechanism remained unclear. In the new work, scientists tested analgesic drugs on mice unable to produce the GIRK2 protein. Allan I. Basbaum of Rockefeller University and his colleagues found that male mutants had lower pain thresholds than normal male mice.

In the second study, R. Adron Harris of the University of Texas at Austin and his colleagues tested varying types of palliative drugs on the mutant mice and found that they all activate GIRK2. The drugs still had some effect on the mutant mice, however, so other pain-mediating mechanisms are most likely at work as well.

Source : Scientific American, December 2002

Compiled by : Kapil Tripathi