Registered with the Registrar of Newspapers of India: R.N. 70269/98

ISSN : 0972-169X
Postal Registration No. : DL-11360/2002

Monthly Newsletter of Vigyan Prasar

DREAM 2047

August 2002 *Vol. 4* *No. 11*

VP News

Report of the First World Space Digital Radio Broadcast

Vigyan Prasar Network of Science Clubs (VIPNET) aims to bring the various VIPNET science clubs closer through the use of technology of satellite radio.

Under this new initiative, Vigyan Prasar has made available digital radio sets to a few selected VIPNET science clubs. Manipur Science and Technology Council has been one such recipient and organizes listening sessions of broadcasts for the benefit of the various science clubs under VP and other enthusiasts in the State of Manipur.

People listening to first broadcast on WorldSpace digital radio

The first experimental broadcast was made of 6th May 2002 at 3.30 p.m. On this occasion, Manipur Science and Technology

Contd. on page 29

Inside

Success of Amateur Radio Enthusiasts

Vigyan Prasar had conducted a training programme for the aspirants of amateur radio operator's licences last year. Four participants had successfully completed the training programme and later on appeared for the licensing examination conducted by the Ministry of Communications. All the four candidates cleared the Grade-I amateur Wireless Telegraph Station Licence. While at present one enthusiast is awaiting his licence, it was a dream come true for the other three enthusiasts when they received their much awaited licence last month.

Mrs. Chandrima Roy (Now a ham radio licensee with the **call-sign VU2CCT**) came to know about amateur radio from Colonel King & Mrs. King at the Agra *PARA BRIGADE* almost ten years back and since then has been harbouring the dream of becoming a ham radio operator. Finally, last year she got the opportunity to join the classes conducted by Vigyan Prasar. The other two enthusiasts who have been awarded with Grade-I licences are **Shri Tonmoy Dev** (an Electrical Engineer by profession and now a ham radio operator with **call-sign VU2TDV**) and **Lt. Col. Dr. Kalpana Sikdar** (VU2DKJ). They were congratulated on their achievement during the monthly meeting of the radio amateurs in Delhi organised by Vigyan Prasar jointly with Amateur Radio Society of India (ARSI) on June 23, 2002. **Shri Rahul Kapoor, VU2YK** (an expert in the field who was licensed during the 1960s) put their achievement like this-"In these days of Internet and mobile telephony, this kind of dedicated effort is very rare to see. The hobby of amateur radio originated at times when communication was a great challenge for the mankind. Today a child can just play with a mobile telephone or chat on the Internet without the need of putting any personal effort. But these enthusiasts still demonstrated that ham radio is alive and would be kicking up. They deserve a greater praise for their consistent effort in becoming ham radio operators."

Vigyan Prasar congratulates and welcomes Mrs. Chandrima Roy and Shri Tonmoy Dev to the ham radio fraternity. ❑

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

Published and Printed by Dr. Subodh Mahanti on behalf of Vigyan Prasar, C-24, Qutab Institutional Area, New Delhi-110 016
Printed at Rakmo Press Pvt. Ltd, C-59, Okhla Industrial Area Phase-I, New Delhi-110 020. Editor: Dr. V.B.Kamble

Keeping Droughts at Bay

India was extremely lucky to enjoy good rainfall since 1989 during the south-west monsoon season every year. This has been the third long spell of normal or excess monsoon rainfall years in the past hundred years, the earlier two spells being in 1921-1940 and 1952-1964. For the country as a whole, the rainfall for the south-west monsoon for this year was expected to be normal according to the predictions of the India Meteorological Department. However, the rainfall has been too late and too little in most parts of the country despite the monsoon season nearing the end. Indeed, continuing dry spell in twelve States is a matter of grave concern. Our country has not experienced a drought as severe and as widespread in last twelve years. Surely, the worst impact has been on the agriculture. Kharif crop has been ruined in most of the affected States. We have already started experiencing power blackouts and water scarcity. Thanks to the plenty of food-grain stocks, it may be possible to tide over the situation till the next monsoon season.

Why did the monsoon fail us this time? Why did the prediction of good rainfall during the present season go wrong? One could attribute the failure of monsoon to a variety of unfavourable factors that may include, sea surface temperatures and pressures, correlation between the warm ocean currents off the south American coast and India called El Nino, snow cover, prevailing atmospheric conditions, global warming and so on. Further, the predictions are based on a mathematical model which needs continuous improvement in view of the new data and better understanding of the weather phenomena. Indeed, even after years of effort and experience, we still have not fully understood the strange behaviour of monsoon. Hence, we need to take monsoon predictions with a pinch of salt and not blame the weatherman should the rain-gods fail us.

Surely, droughts are nothing new to us. It has been a frequent and a natural phenomenon and follows a cyclical pattern. In last fifty years, we have experienced fourteen major droughts, the one in 1987 being the most severe that affected nearly half the land of our country. Then, how is it that after a bonanza of thirteen consecutive normal monsoons, the failure of monsoon this year has suddenly caught us unawares? Indeed, drought, or no drought, we need to manage our water resources efficiently, if we do not want the monsoon showers to make or break our fortunes.

There is no gainsaying the fact that unless we learn to "manage" a drought, it could become synonymous with the visions of parched earth, cracks in cultivable lands, unemployment, thirst, hunger and death. Anil Aggarwal always maintained that the entire nation could be made drought free through community rain water harvesting. His vision has become a reality in parts of Rajasthan, thanks to the commitment and foresight of Dr. Rajendra Singh and his team Tarun Bharat Sangh, who were instrumental in mobilizing communities to rejuvenate their own water resources. The traditional water harvesting structures built by the villagers under his guidance have changed the face of Rajasthan's Alwar and neighbouring districts of Jaipur, Sawai Madhopur and Karoli making them drought free. River Ruparel started flowing perennially after three decades. Indeed, it is among the 5 rivers of Alwar that has seen life after death. We have yet another success story in Maharashtra at Ralegaon Siddhi where the efforts on watershed management of Anna Hazare have helped a dry region become green through community participation and existing Government schemes. Why can't we follow the path shown by Rajendra Singh and Anna Hazare in other parts of the country as well?

Good water management can help create sufficient reservoirs to be used in the times of crisis. A case in point is the example set by the Rashtrapati Bhavan in rainwater harvesting to meet its water requirements. With a rain water system in place, its annual water requirement totalling 730 million litres is easily met. Regular workshops and training programmes to educate and apprise people on how to harvest rainwater would go a long way in tackling scarcity of water. A campaign to create awareness and provide practical information on rainwater harvesting needs to reach out to co-operative group housing societies and residential colonies, especially in the metros. Such programmes have largely remained a non-starter till now. It could now gain momentum. Let us begin right away.

The immediate task in drought affected areas is to ensure the availability of food and drinking water to both human and animal population. This is so because in many parts of the country, livestock and livelihood are intimately related. Professor M. S. Swaminathan even visualises establishment of Community Food Banks and Community Water Banks by the Government and operated by the self-help groups. He also suggests an integrated agricultural rescue package consisting of crop life-saving techniques, contingency planning, alternative cropping systems, and compensatory production programmes in areas where there is enough soil moisture. This would help in reducing the aggregate fall in agricultural production.

Government has already embarked upon the programmes such as food for work and employment for drought victims. It is this time that socially and ecologically relevant programmes could be initiated, say, construction of check-dams, digging farm ponds in rural areas where rain water could be stored and utilized for irrigation, deepening of existing ponds and lakes and so on. It is imperative to help people understand their own role and responsibility in mitigating drought, and equip them with necessary information, skills and training to keep drought at bay. It is raining opportunities for the science communicators and voluntary agencies to take up this challenge. This way we would have enough water the year round, and not just when it rains.

❒ **V. B. Kamble**

Editor : V.B. Kamble

Address for correspondence : Vigyan Prasar
C-24, Qutab Institutional Area, New Delhi-110 016
Tel: 6967532; Fax: 6965986
e-mail : vigyan@hub.nic.in
website : http://www.vigyanprasar.com

A. P. J. Abdul Kalam

A President with a Difference

We have made significant achievements in the last fifty years in food production, health sector, higher education, media and mass communication, industrial infrastructure, information technology, science and technology and defence. Our nation is endowed with natural resources, vibrant people and traditional value system. In spite of these resources, a number of our people are below the poverty line, undernourished and lack primary education…Along with speedy development aimed at elimination of poverty and unemployment, national security has to be recognized by every Indian as a national priority. Indeed, making India strong and self-reliant—economically, socially and militarily—is our foremost duty to our motherland and to us and to our future generations.

Dr. Kalam in his speech on the occasion of his assumption of the office of President of India on July 25, 2002

Avul Pakir Jainulabdeen Abdul Kalam, popularly known as Dr. A.P.J. Abdul Kalam, the son of a little educated boat-owner in Rameswaram, Tamil Nadu, has become the 11th President of the Republic of India. The names of the earlier Presidents of India are: Dr. Rajendra Prasad, S. Radhakrishnan, Zakir Hussain, Fakhruddin Ali Ahmed, V. V. Giri, Neelam Sanjeev Reddy, Gyani Zail Singh, R. Venkataraman, Dr. Shankar Dayal Sharma and K. R. Narayanan. Dr. Kalam is the first scientist to occupy the Rashtrapati Bhavan. In that sense it is very significant. He is a man who has taken unto himself the task of changing the destiny of India. He is a man with a vision. His vision is to make India a developed country. He has given his plan of action and a road map for realizing his vision. He has articulated his thoughts in his three books: *India 2020: A Vision for the New Millennium, Wings of Fire: An Autobiography of A. P. J. Abdul Kalam* and *Ignited Minds: Unleashing the Power Within India.* The Young India has already started looking to Dr. Kalam for inspiration and guidance.

Dr. Kalam was born on October 15, 1931. He had a secured childhood both materially and emotionally. To quote from his autobiography *Wings of Fire*: "I was born into a middle-class Tamil family in the island town of Rameswaram in Madras state. My father, Jainulabdeen, possessed neither much formal education nor much wealth; despite these disadvantages, he possessed great innate wisdom and a true generosity of spirit. He had an ideal helpmate in my mother, Ashiamma. I do not recall the exact number of people she fed everyday, but I am quite certain that far more outsiders ate with us than all the members of our own family…We lived in our ancestral house, which was built in the middle of the 19th century. It was a fairly large pucca house, made of limestone and brick, on the Mosque Street of Rameswaram. My austere father used to avoid all inessential comforts and luxuries. However, all that was needed was provided for, in terms of food, medicine or cloths. In fact, I would say mine was a very secure childhood, both materially and emotionally." Dr. Kalam's father commanded a high respect as a religious man. Dr. Kalam has acknowledged that his scientific accomplishment and his views are very much influenced by his parents and other well-wishers. To quote him from his autobiography : "Every child is born, with some characteristics, into a specific socio-economic and emotional environment, and trained along the way, in certain ways by figures of authority. I inherited honesty and self-discipline from my father; from my mother, I inherited faith in goodness and deep kindness as did my three brothers and sisters. But it was the time I spent with Jallalluddin and Samsuddin that perhaps contributed most to the uniqueness of my childhood and made all the difference in my later life. The unschooled wisdom of Jallauddin and Samsuddin was so intuitive, responsive to non-verbal messages that I can unhesitatingly attribute my subsequently manifested creativity to their company in my childhood." It may be noted that Ahmed Jallaluddin was a close friend of Dr. Kalam and Samsuddin was his first cousin.

The Chief Justice of India Shri B.N. Kirpal administering the oath of office of the President of India to Dr. A.P.J. Abdul Kalam at a Swearing-in-ceremony in the Central Hall of Parliament in New Delhi on July 25, 2002

After studying in a primary school in Rameswaram, Dr. Kalam went to Schwartz High School at Ramanathpuram from where he went to Tiruchchirapalli for his higher studies. Dr. Kalam wrote : "By the time I completed my education at Schwartz, I was a self-confident boy with the determination to be successful. The decision to go in for further education was taken without a second thought. To us, in those days, the awarness of the possibilities for a professional education did not exist; higher education simply meant going to college. The nearest college was at Tiruchchirapalli, spelled Trichinopoly those days, and called Trichi for short."

After completing his BSc from St. Joseph's college he joined the Madras Institute of Technology (MIT), for studying aeronautical engineering. From MIT, he went to Hindustan Aeronautics Limited (HAL) at Bangalore as a trainee. As aeronautical engineer Dr. Kalam had two options — to join the Directorate of Technical Development and Production, or DTD & P (Air) of the Ministry of Defence or the Indian Air Force. As he could not make it to Indian Air Force, Dr. Kalam joined the Technical Centre (Civil Aviation) of the DTD&P (Air) as Senior Scientific Assistant on a basic salary of Rs. 250/-. While working at the Directorate he got a chance to realise his dream. He joined the Indian Committee for Space Research (INCOSPAR), the predecessor of the Indian Space Research Organisation (ISRO). And thus Dr. Kalam started his much talked about career in rocket and missile technology.

Before he became President of the country, Dr. Kalam had divided his career in four phases. In the first phase (1963-82) he worked with ISRO. At ISRO he served in various capacities. After initiating Fibre Reinforced Plastics (FRP) activities and spending some time with the aerodynamics

and design group he joined the satellite launching vehicle team at Thumba. Here he was made the Project Director of the Mission for SLV-3. He played a crucial role in developing satellite launch vehicle technology and expertise in control, propulsion and aerodynamics. The SLV-3 project managed to put Rohini, a scientific satellite, into orbit in July 1980. India also acquired the ability to design various kinds of rocket systems. Commenting on the first phase of his career Dr. Kalam wrote: "This was my first stage, in which I learnt leadership from three great teachers—Dr. Vikram Sarabhai, Prof. Satish Dhawan and Dr. Brahm Prakash. This was the time of learning and acquisition of knowledge for me."

The second phase of his career started when he joined the Defence Research and Development Organisation (DRDO) in 1982. As Director of DRDO, Dr. Kalam was entrusted with the Integrated Guided Missile Development Programme (IGMDP). Under his leadership India has been able to develop strategic missiles like *Nag* (an anti-tank guided missile), *Prithvi* (a surface to surface battlefield missile), *Akash* (a swift, medium range surface-to-air missile), *Trishul* (a quick-reaction surface – to – air missile) and *Agni* (an intermediate range ballistic missile).Three new laboratories/facilities in the area of missile technology were established. About this phase Dr. Kalam wrote: "During this stage, I have gone through many successes and failures. I learnt from failures and hardened myself with courage to face them. This was my second stage, which taught me the crucial lesson of managing failures." Dr. Kalam's contribution to India's defence capabilities is very significant.

Dr. Kalam identifies his third phase with his participation in India's mission to become a nuclear weapon state, jointly undertaken by DRDO and Department of Atomic Energy (DAE) with the active support of the armed forces. During this phase he, as Chairman of the Technology Information, Forecasting and Assessment Council (TIFAC), also got involved with the creation of Technology Vision 2020 and the India Millennium Missions (IMM 2020), which is an integratied version of technology vision and India's security concerns. In November 1999 Dr. Kalam was appointed as Principal Scientific Adviser to the Government of India.

Vigyan Prasar, while felicitating Professor APJ Abdul Kalam an humble and great scientist; and the first citizen, takes the pledge to fully dedicate itself to turn his dream of transforming our country into a developed nation.

Editor

His fourth phase started after he left the post of Principal Scientific Adviser. He joined the Anna University at Chennai as Professor of Technology and Societal Transformation. As part of realizing his mission he decided to ignite the minds of the young. For this purpose he wanted to reach at least 100,000 students in different parts of the country before August 2003. He has already met about 40,000 students. His fourth phase took a sudden turn, which he himself perhaps did not visualize. He became the President of India.

In 1997 Dr. Kalam was given the highest civilian award of India, the Bharat Ratna. Earlier Dr. Kalam was awarded Padma Bhushan (1981) and Padma Vibhushan (1990) by the Government of India. He is also recipient of several other awards, including the Indira Gandhi Award for National Integration (1997). Dr. Kalam has been conferred with Degree of Doctor of Science (DSc *honoris causa*) by a number of universities. Dr. Kalam is a Fellow of Indian Academy of Sciences (Bangalore) and the National Academy of Engineering. He has also been President of the Aeronautical Society of India.

❒ Subodh Mahanti

Contd. from page ...32

Council, with the help of the WorldSpace radio, had arranged a listening session for the various science clubs, NGOs, individuals, etc. at the Seed Technology Hall of Modern College, Imphal.

Twenty five participants from various science clubs, NGOs including a few individuals interested in the field attended the listening session. Since, the activity of the satellite radio is a new one, it was a unique experience for the listeners as they could hear talks from eminent scientists with a crystal-clear quality of sound.

After the broadcast was over, a small function was organized with Shri N. Bhogen Singh, Principal, Modern College, Imphal in the Chair. Shri Kh. Rakesh addressed the participants about the new missions of VP designed for communicating scientific information to the people in general and the various science clubs in particular through WorldSpace digital radio system. He also assured of arranging regular listening sessions when the schedule is finalized by VP. Shri Ch. Rajendra Shngh of Imphal College, Imphal, gave a short speech on the working principle and utility of the digital radio system.

The listening session was closed with a request from the Principal, Modern College, Imphal, to Vigyan Prasar to broadcast regular programmes in the long run for the benefit of the people.

Shri L. Somarjit Singh, Secretary, MASCA conducting the function after the listerning session.

• • •

National Science Centre

❒ N.R. Iyyer*

The National Science Centre is a constituent unit of the National Council of Science Museums, which is an autonomous organisation under the Department of Culture, Ministry of Tourism and Culture, Government of India. It is a pioneering institute engaged in the popularisation of science in the northern part of India since 1992. The Centre, since its inception, has received more than two million visitors. The centre is located next to the Gate Number 1 of Pragati Maidan on Bhairon Road, New Delhi.

The Centre is engaged in the service of the society by popularising and enhancing public understanding of science and technology through interactive and user-friendly exhibits and plethora of activities, thereby creating a scientific temper. There are two main spheres of activities aimed to achieve this goal of popularising science. The first involves conceptualisation, design and development of interactive, hands on exhibits, explaining different scientific concepts, which are displayed in the four major galleries of the Centre. The other sphere of our activity involves planning, organisation and conduct of innovative educational activities that supplement traditional classroom science teaching.

A view of the Main Building of National Science Centre, New Delhi

The main objectives of the Centre are:

- *Popularisation of Science among the general public at large and students in particular.*
- *Efforts to achieve scientific literacy in the country.*
- *To inculcate Scientific Awareness and Scientific Temper.*
- *To organise various educational programmes for the benefit of students, teachers & society.*
- *Supporting curriculum based education at school and college level by imparting teachers training.*
- *Encourging inquisitive minds to inculcate innovative ideas.*
- *Display and demonstration of progress and achievements in various fields in science and technology.*

The Centre presently has on display four permanent galleries on different scientific themes. The first gallery, which depicts the rich scientific heritage of India, is titled **"Indian Heritage"**. The most popular gallery of the Centre is **"Fun Science"**, which has around 100 hands-on interactive exhibits explaining scientific principles in interesting way. The **"Information Revolution"** gallery shows the relation between society and advancement in information technology. The gallery also has quite a few interesting artefacts. This gallery has been awarded the prestigious Dibner Award by Smithsonian Institution, USA. The **"Emerging Technology"**, gallery presents the technology available in India for use in rural areas. A very large **"Energy Ball"** exhibit and a permanent enclave on **"Dinosaur"** with four life-like robotic dinosaurs situated in their natural ambience are other attractions at the Centre.

The National Science Centre also has a convention complex consisting of an auditorium, carpeted and air-conditioned auditorium with a seating capacity of 330 people and a conference room multiplex.

A brief outline of the educational programmes and activities conducted round the year is as below

TARAMANDAL

This is a mini portable planetarium with an inflatable dome, to accommodate 30 visitors and they all can interact with the explainer. The 30 minutes show leaves them spell bound with the unique experience.

POPULAR SCIENCE SHOW

A unique experience for the visitors to see science in action. Simple but thrilling experiments are performed here, which appear like magic and the explanation follows. Topics like 'Science behind beliefs', 'Liquid Air Show', Unexpected Science' are organised at regular intervals.

SCIENCE DEMONSTRATION LECTURE

These lectures are aimed at the school students and teachers and they are related to the curriculum of Physics, Chemistry and Life Science. The lectures are normally arranged on request by the schools or during the cyberpicnic programmes.

COMPUTER AWARENESS PROGRAMME

To de-mystify computers to the young students, this programme is conducted in batches throughout the year. Through internet connectivity, the students connect to the world of information.

CREATIVE ABILITY CENTRE

Many school students who learn science in schools develop ideas for experiments and models to test scientific concepts. These ideas are sought to be translated into reality by the students, but then, due to the lack of infrastructural facilities at home, building these models may not always be possible. The Centre helps these students to translate their ideas into reality through Creative ability Centres.

World Mental Health Week

ANNUAL SCIENCE QUIZ CONTEST

It is open for school students of Delhi and also for neighbouring suburbs and is conducted throughout

Summer Vacation Hobby Camps-2002

the year. Attractive prizes are awarded to the winners.

NORTHERN INDIA SCIENCE FAIR

The Centre in collaboration with the Education Departments of 8 Northern States and Union Territories in the Northern Zone, provides an opportunity to the students and teachers to exhibit projects and teaching aids on different themes. The event is aimed at instilling the right concepts and dispelling misconceptions in science, and showing what is possible and what is not in science. The winners of the State level are invited for the Northern India Science and Engineering Fair held during January/February every year.

STUDENTS' SCIENCE SEMINAR

As a part of the National Science Seminar conducted every year by the National Council of Science Museums, the Centre organises Seminar in the North Zone in collaboration with the Education departments of Northern states and Union Territories every year during August/September.

COMMEMORATIVE EVENTS

In order to make people aware and appreciate the personalities behind the scientific development and to remember the events leading to discoveries and inventions the Centre also commemorates various special days like World Health Day, World Telecommunication Day, World Environment Day, World Population Day, World AIDS Day, National Energy Conservation Day, World Ozone Day, World No Tobacco Day etc. These events are celebrated with a variety of programmes such as Science Quiz, Painting Competition, scientific debate, and quiz for staff etc. followed by a cultural event.

POPULAR SCIENCE LECTURES

Science is considered to be a difficult subject by many. This misconception is sought to be dispelled by organising Popular Science Lectures for students and the general public. In this programme, renowned scientists talk about their own work or other topics of current scientific relevance in very simple terms so that concepts are made easy to understand. Many great scientific minds like Nobel Laureates Sir Paul Nurse and Harold Kroto, Z A Qasim, R A Mashelkar, J V Narlikar, and Prof Yashpal, to name a few have addressed the audience in the Centre.

The Centre also collaborates with like minded institutions in the city in this task of science popularization. Institutions such as DST, Vigyan Prasar, National Museum of Natural History, National Rail Museum, etc. have associated themselves with the Centre in one way or the other at different times.

The Centre is located centrally on Bhairon Marg, near Gate No:1 of Pragati Maidan New Delhi and is open from 10 AM to 5:30 PM on all days of the year except on Holi and Diwali.

The National Science Centre is therefore the hub of scientific activity for all over the northern part of the country round the year.

* N.R. Iyyer is a Curator at National Science Centre, New Delhi

• • •

"DREAM-2047"-HINDI, ENGLISH OR BOTH ?"

Since its inception "Dream-2047" is being brought out in bilingual form (Hindi & English). Recently it has been suggested that Dream-2047 now on should be brought out in Hindi & English separately. Before we take a decision, we would like to have our readers' views on this.

How would you like to receive 'Dream-2047' in future ? Please tick mark on your choice below.

i) Only in Hindi ☐
ii) Only in English ☐
iii) Both in Hindi and English ☐

Please send your response before September 20, 2002 positively.

Name : .....

Organisation : .....

Address : .....

.....

Telephone : .....Fax: .....

E-mail : .....

Niels Bohr

Who Made the Atom Stable

❒ Subodh Mahanti

In Denmark I was born, there is my home,
there are my roots, from there my world unfolds…

Hans Christian Andersen (what Andersen said was equally true for Niels Bohr)

Not often in life has a human being caused me such joy by his mere presence as you did.

Albert Einstein in a letter to Niels Bohr

Even more than Einstein, Niels Bohr had created new ways of looking at the world in the first half of the 20th century. With the Bohr atom, science began a journey that continues to amaze, disturb, and enlighten today. Under his stewardship the quantum revolutions brought to light some of the finest minds of 20th century physics, a truly astonishing group of brilliant and innovative scientists, who in turn sowed the ideas that have so profoundly changed our world and the way that we attempt to understand it.

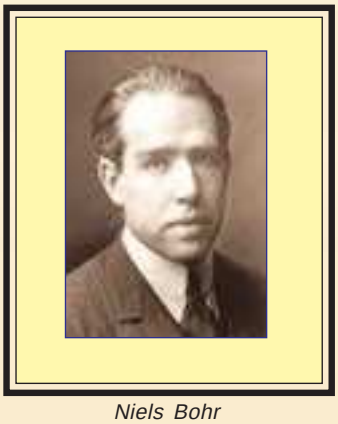
Ray Spangenburg and Diane K Moser in *Niels Bohr* : *Guntle Genius of Denmark*

I think it is safe to say that no one understands quantum mechanics. Do not keep saying to yourself, if you possibly, avoid it, 'But how can it be like that ?, because you will go 'down the drain ; into a blind alley from which nobody has yet escaped. Nobody knows how it can be like that."

Richard Feynman

Niels Henrik David Bohr was one of the most respected theoretical physicists of the twentieth century. By introducing conceptions borrowed from the quantum theory, Bohr succeeded in working out a picture of atomic structure that with later improvements still fitly serves as an elucidation of the physical and chemical properties of the elements. In 1922 Bohr received the Nobel Prize for physics for his work on the structure of atom.

During World War II Bohr did his best to rehabilitate Jewish scientists who where forced to leave Germany and the countries occupied by Adolf Hitler (1889-1945). He himself made a dramatic escape from Denmark and fled to the USA. In 1943 Bohr worked on the atom bomb project. However, after realising the great danger from such bomb he spent the rest of his life working on peaceful ways of using atomic energy.



Niels Bohr

Bohr was a great leader and mentor. He had an insatiable curiosity. He was a great inspirer. There were few who came in contact with Bohr and were not inspired to put forth their best. He drew the best students of physics from all over the world. Above all he was a great humanist.

Bohr really epitomised the heroic image of a scientist. He had no hesitation to admit when he was in error. Einstein once commented : "He (Bohr) utters his opinions like one perpetually groping and never like one who believes to be in possession of a definite truth." He continued to work till his death. In fact a diagram drawn on his study blackboard the night before his death to overcome the arguments of Albert Einstein has been kept unchanged.

Bohr was born on October 07, 1885. His mother Ellen Adler was daughter of a prosperous Jewish banker and politician. His father Christian Bohr was a son of a school teacher. Christian Bohr was a Professor of Physiology at the University of Copenhagen and had a deep interest in science, art and philosophy. Christian had published his first scientific paper at the age of twenty-two. Christian was politically and socially progressive. He was a religious skeptic and an early advocate of women's rights. Christian was also a sports enthusiast and was instrumental in popularising soccer in Denmark. Christian encouraged his children by providing opportunities for them to explore their interests. Bohr grew up in an environment that encouraged independent development, human compassion and culture. His parents instilled in him a great love for knowledge and its pursuit.

Bohr had an elder sister Jenny and younger brother, Harald who distinguished himself as a mathematician. The two brothers remained best friends thoughout their life. His sister pursued a career teaching history and Danish. Bohr and also his brother Harald completed their elementary and high school studies at Gamelholm Grammar School. Bohr was not always first in his class. However, he was regularly third or fourth from the top. He displayed great abilities in mathematics and science. Bohr was an avid and excellent athelete.

After matriculation at the Gamelholm Grammar School in 1903 Bohr joined the University of Copenhagen. His brother followed him there. Bohr developed a fascination for poetry and memorised many stanzas in German and Danish. He also read philosophy including the works of the Danish philosopher Soren Aabye Kierkegaard (1813-55). At the university Bohr and his brother studied philosophy under their father's friend Harold Hoffding. They had also formed a discussion group with some of their classmates. Bohr also enjoyed fiction. He particularly valued a little book titled *Tale of*

a Danish Student by the Danish writer Paul Martin Moller. In this book the student is to sort out the many dualities inherent in life. For example Moller wrote : "Thus on many occasions man divides himself into two persons, one of whom tries to fool the other, while a third one, who in fact is the same as the other two, is filled with wonder at this confusion. In short, thinking becomes dramatic and quietly acts the most complicated plots with itself, and the spectator again and again becomes actor". Bohr was always fascinated with duality — two things at once.

Hans Christian Andersen

In 1905, the Royal Danish Academy of Sciences and Letters had proposed an award for the best paper on the surface tension of liquids. Bohr decided to participate in the competition. At that time he was 19 years old. His father made him available the facilities of his physiology laboratory. Lord Rayleigh (1842-1919) had proposed that it was possible to determine the surface tension of a liquid if a few factors were known, for example, the length of waves that formed on a jet of the liquid, the speed of the jet and its cross section. Bohr devised a method for producing a jet of water that would always have the same speed and cross section. He worked in the nights for months. Finally he submitted a paper. Though the paper was inconclusive, Bohr while extending Raleigh's basic theory about surface tension of liquids, raised some important questions. He was declared one of the winners of the competition. A paper based on this work was published in 1909 in *Philosophical Transactions* of the British Royal Society. The paper was titled "Determination of the Surface Tension of Water by the Method of Jet Vibration."

Albert Einstein

Bohr received his bachelor's degree from the University of Copenhagen in 1907. He continued to work as a graduate student. He took his Master's degree in Physics in 1909 and his Doctor's degree in 1911. His thesis work was on the subject of the electron theory of metals. Bohr defended his thesis, which he dedicated to the memory of his father 'with deepest gratitude' on May 13, 1911. Bohr's father had died few months before this at the age of 56 and he was buried in one of Copenhagen's oldest cemeteries near the graves of the physicist Hans Christian Oersted (1777-1851) and the Danish writer Hans Christian Andersen (1805-75). Commenting on Bohr's defence of his PhD work, a local newspaper reported : "Dr. Bohr, a pale and modest young man, did not take much part in the proceedings, the short duration of which a record... The words Bohr had written and the questions he had raised were literally so new and unusual that no one was equipped to question them." Bohr's doctoral work remains to this day a classic on the subject.

Richard Feynman

Bohr could never master the language he spoke or wrote. In fact in his school, Bohr's worst subject had been Danish composition. It is said that even for writing a postcard Bohr would first prepare a draft. Bohr was not at all comfortable in writing. He dictated entire doctoral thesis to his mother. While Bohr's father thought that a PhD student should write his own thesis but his mother firmly believed the task was hopeless. Most of Bohr's later work and correspondence were dictated to his wife and his secretaries or co-workers. He took long time to write a paper. Seven or eight drafts were very common. Bohr shaped his ideas while orally communicating with other fellow physicists.

Before his death, Bohr's father had helped arrange a grant for his son's post- graduate work in England for a year. The grant was given by Carlsberg Brewery, producer of excellent quality beer. Bohr arrived in Cambridge, England, in late September 1911 to work under the guidance of Joseph John Thomson (1856-1940), the discoverer of the electron and head of the famous Cavendish Laboratory. The first Director of the Cavendish Laboratory was James Clerk Maxwell (1831-1879) who was succeeded by Lord Rayleigh. Thomson had taken the place of Rayleigh at the age of 28. At the time when Bohr reached Cambridge Thomson was 50 years old. Ernest Rutherford (1871-1937) had also come to Cambridge to work under Thomson but 16 years earlier than Bohr. In the very first meeting with Thomson, Bohr did not hesitate to point out his reservations on Thomson's theory of atom. Bohr had thought a great deal about Thomson's 'plum pudding' atom, and he was almost convinced that it could not be correct. It may be noted that based on his discovery of the electron, Thomson had suggested in 1898 that atoms were spheres of positively charged matter with negatively charged electrons embedded in them in a uniform manner—something like a 'plum pudding'. He presented Thomson his PhD thesis on the application of electron theory to metals – with the hope that Thomson might read it and discuss it with him. For Bohr to meet Thomson was a great event. He wrote to his brother: "Things are going so well for me. I have just been talking to J.J. Thomson and have explained to him, as well as I could, my ideas about radiation, magnetism, etc. If you only knew what it meant to me to talk to such a man. He was extremely nice to me, and we talked about so much; and I do believe that he thought there was some sense in what I said. He is now going to read (my thesis) and he invited me to have dinner with him Sunday at Trinity College; then he will talk with me about it."

Bohr had started working on cathode ray production at the suggestion of Thomson. But apparently he did not enjoy his work. Otherwise he enjoyed his stay at Cambridge. He joined a soccer club and did ice skating. After a few months Bohr went to meet Thomson again. The meeting was very cordial but Bohr realised that Thomson had not read his thesis. Bohr was greatly discouraged. Later in his life, Bohr while commenting on his stay at Cambridge, would say : "The whole thing was very interesting in Cambridge but it was absolutely useless." He wanted to change his work place and accordingly he contacted Rutherford, who was then working at Manchester. Rutherford welcomed Bohr's idea but he also advised him to first complete the work at Thomson's laboratory. Bohr completed the work and told Thomson that "he would like to work with Rutherford as he would like to know something about radioactivity".

Bohr arrived at Manchester in March 1912. Here he found the atmosphere quite stimulating. Under the leadership of Rutherford the physics laboratory of the Manchester University was fast emerging as one of the most productive in the world. Rutherford created around himself an atmosphere of intellectual excitement and openness. E. Andrade, one of

Rutherford's collaborators while commenting on Rutherford's style of working, wrote : "Although there was no doubt as to who was the boss, everybody said what he liked without constraint... He was always full of fire and infectious enthusiasm when describing work into which he had put his heart and always generous in his acknowledgement of the work of others."

Each afternoon all people working in Rutherford's laboratory used to meet on tea. Rutherford also participated at these daily get-togethers. Besides discussing their research work they would discuss politics and sports. Ideas were freely exchanged. It was a time when so many important things were happening in physics and so nobody lacked an interesting topic to discuss.

Adolf Hitler

In Manchester, Bohr was placed under George Charles von Hevesy (1885-1966), who was also of the Bohr's age. At the time Hevesy was trying to separate radioactive decay products from their parent substance, a problem undertaken at the instance of Rutherford. It was Hevesy who developed the science of using radioactive traces in medical and biological research. Hevesy was awarded the 1943 Nobel Prize for chemistry. Bohr greatly profited from Hevesy's extensive knowledge of radiochemistry. Bohr also undertook an eight-week laboratory course in the experimental methods of radioactive research. One of his instructors was Hans Wilhelm Geiger (1882-1945). It may be noted that Geiger, a pioneer in nuclear physics, developed a variety of instruments and techniques used for detecting and counting individual charged particles. Geiger along with E Marsden investigated the scattering of alpha particles by gold leaf (1909), a work which led Rutherford to propose his nuclear theory of atom. After completing this course Bohr started studying the absorption of alpha particles in aluminium at the instance of Rutherford. Commenting on his impression of Rutherford's working style Bohr wrote to his brother : "...Rutherford is a man you can rely on ; he comes regularly and enquired how things are going on—talks about the smallest details... Rutherford is such an outstanding man and really interested in the work of all the people around him...."

Lord Rayleigh

After completing his one year post-doctoral study Bohr left Manchester for his homeland on July 24, 1912. At that time Bohr's country Denmark was not a proper place for doing research work in physics. Then Denmark had only one university – the University of Copenhagen. The University had only one professorship in physics, which was then occupied by Christian Christiansen, Bohr's teacher. When Christiansen resigned from the post on August 31, 1912 it went to Martin Knudsen though Bohr had also applied for the post. Even Bohr could not get the docentship (a much lower paid position) in physics as Knudsen recommended his own assistant for this post. Bohr had to content himself with a post of teaching assistant offered by Knudsen.

Irrespective of his position in the University, Bohr started working in real earnest. He wanted to see how the quantum theory could be applied to explain the structure of atom. He had started working in this direction while he was in Manchester. Bohr was quite convinced that to demonstrate that Rutherford's model is a physical reality would require altogether a new approach. That is how he turned to quantum theory. Bohr had commented later : "It was clear and, that was the point about the Rutherford atom, that we had something from which we could not proceed at all in any other way than by radical change." The quantum theory originated from a paper of Max Karl Ernst Ludwig Planck (1858-1947) published in 1900. In this paper titled `On the Theory of the Law of Energy Distribution in the Continuous Spectrum' Planck proposed that certain experimental results could best be understood if it were assumed that substances emit light only of certain energies and not other. In other words Planck assumed energy changes take place in small discrete installments or quanta. The quanta is a Latin word and it means `How much'. In mathematical term Planck's idea can be expressed as $E=nh\nu$ where E is the energy of the light source, n is a positive integer (i.e. 0,1,2,3, and so on), ν (nu) is frequency and h is a constant now called Planck's constant. Thus each energy has a fixed value. Einstein went one step forward. In 1905 he proposed that light not only comes in quanta but it is a bundle of quanta or of discrete particles. Thus light or electromagnetic radiation is a flow of these discrete particles. And the intensity of radiation or light is the flux of these quanta.

Soren Aabye Kierkegaard

The first problem Bohr faced was to explain the stability of the atom. As Rutherford had proposed that the atom's mass would be contained in the nucleus, and an equal number of negatively charged electrons would be found in motion somewhere outside the nucleus. This model, the so-called planetary model, was proposed by Rutherford in 1911. However, this model had a fundamental problem. This model was theoretically unstable. Its stability could not be explained by the laws of classical or Newtonian physics. Unlike planets orbiting the Sun, electrons are charged particles. In the 19th century, Michael Faraday (1791-1867) and Maxwell had shown that an electrically charged particle gives off radiation if it is diverted from straight path. So as an electron moves in a circular path it would emit radiation and consequently it would lose energy and the electron would describe smaller and smaller tracks with a declining period of revolution and finally rush in towards the positive nucleus. Thus the track would be a spiral.

Joseph John Thomson

Bohr proposed that the electrons could revolve around the nucleus in only "certain orbits" or certain energy levels, each orbit having a different radius. And as long as electrons revolve around the nucleus in such "allowed orbits" they do not radiate or lose electromagnetic radiation or energy, even though they have accelerated motion around the nucleus. But electrons could jump spontaneously from one allowed orbit

to another and then they would absorb or release energy in packets or quanta. If electrons move inward, toward the nucleus, into an orbit having a smaller radius, they would release energy. Conversely when they move away from the nucleus into orbit of a larger radius they would absorb energy.

By the end of 1913 Bohr published three papers which have come to be known as 'Bohr's 1913 trilogy'. These papers were titled:

1. On the Constitution of Atoms and Molecules (Part – I)
2. Systems Containing only a Single Nucleus (Part –II)
3. Systems Containing Several Nuclei (Part – III)

Bohr sent the draft of the first paper to Rutherford for his comments on March 16, 1913. Rutherford in his letter dated March 20, 1913 wrote :"... your ideas as to the mode of origin of the spectrum of hydrogen are very ingenious and seems to work out well...but the mixture of Planck's ideas with the old mechanics make it very difficult to form a physical idea of what is the basis of it. ... There appears to me one grave difficulty in your hypothesis, which I have no doubt you fully realize, namely, how does an electron decide what frequency it is going to vibrate at when it passes from one stationary state to the other ! It seems to me that you would have to assume that the electron knows beforehand where it is going to stop."

James Clerk Maxwell

Despite his apprehension Rutherford decided to communicate the paper to *Philosphical Magazine,* after correcting Bohr's English and making necessary changes. So he concluded the abovementioned letter by saying : "I suppose you have no objection to my using my judgment to cut any matter I may consider necessary in your paper ! Please reply!"

Instead of writing a letter Bohr personally came to Manchester to convince Rutherford communicating the paper intact. They together analysed the paper section by section and Rutherford after listening Bohr's argument sent the paper after making few corrections to Bohr's English. All the three papers were published by the end of 1913 in the same journal.

George Charles von Hevesy

Today the far reaching implications of these papers in the growth of physics are well-known. In these papers Bohr not only gave a highly useful model of the atom but he also showed that quantum mechanics was a fundamental part of how nature worked. It may be noted that Newtonian physics or the classical physics which explained the working of nature on the larger scale failed to explain the behaviours of the subatomic particles. Bohr's ideas were radical. Most of the scientists were not ready to accept them. As pointed out by Otto Robert Frisch (1904-79), "That picture was so unorthodox at the time that a number of physicists...had sworn to give up physics if that nonsense (Bohr's atomic model) was true". Even scientists like Thomson, Lord Rayleigh and Einstein were not much enthused. In 1914 Rutherford said : "while it is too early to say whether the theories of Bohr are valid, his contributions...are of great importance and interest." And again in the same year Rutherford said : "N. Bohr has faced the difficulties by bringing in the idea of the quantum. At all events there is something going on which is inexplicable by the older mathematics." Towards the end of his life Einstein commented : "That this insecure and contradictory foundation (of physics in the early part of the 20th century) was sufficient to enable a man of Bohr's unique instinct and tact to discover the major laws of the spectral lines and of the electron shells of the atoms together with their significance for chemistry appeared to me like a miracle and appears to me as a miracle even today. This is the highest form of musicality in the sphere of thought."

Ernst Rutherford

It should be noted that Bohr's model of the atom was by no means the last word. Ideas of the atom have undergone substantial changes since his announcement in 1913. Bohr himself knew that his model was nothing but a sketchy approximation of reality. As Frisch would later recall : "Bohr himself was very much aware of the crudeness of that model ; it resembled the atom no more than a quick pencil sketch resembles a living human face. But he also knew how profoundly difficult it would be to get a better picture".

In 1914 Bohr was appointed as Professor of Theoretical Physics. It was Bohr, who for the first time, started teaching of theoretical physics as a separate subject at Copenhagen University. But before Bohr took up this assignment he was offered by Rutherford a two-year readership at Manchester. Bohr decided to take up the opportunity to work directly with Rutherford. After taking permission from the University that he can join the post after two years Bohr left for Manchester. In 1916 Bohr returned to Denmark. It may be noted that the first World War was in full swing at that time.

In 1917 Bohr submitted a proposal to the University of Copenhagen for establishing an institute of theoretical physics as part of the University. The proposal was accepted by the University after the end of the war and Bohr collected about $20,000 for constructing a building to house the institute. When Bohr was in the process of laying the foundation of his institute he got an offer from Rutherford of a permanent Professorship in Mathematical Physics at Manchester University where a new centre was created for conducting research in modern physics. Rutherford wrote : "You know how delighted we would be to see you working with us again. I think the two of us could try and make physics boom, well think it over and let me know your mind as soon as you can. Possibly you might think of visiting us as soon as the seas are clear." Further he continued "I wish I had you here to discuss the meaning of some of my results on collision of nuclei. I think I have got some rather startling results."

Hans Wilhelm Geiger

For any young scientist it was a great honour, an offer coming from a great scientist like Rutherford. Moreover, financially it was more lucrative to work in an English university than in Denmark. But Bohr, being a great patriot, did not accept

the offer. Thus instead of opting for working in an established laboratory and as a colleague of Rutherford he decided to stay in Denmark to establish his proposed institute. Building the institute in war-ravaged economy was not an easy task. But Bohr's resourcefulness somehow made it possible. The Institute of Theoretical Physics was formally inaugurated in September 1921. Bohr became its first director, a post he held till his death. Bohr started living on the upper floor of the Institute. Bohr made the Institute the ultimate place for theoretical physics in the world. To quote Spangenburg and Moser : "During the 1920s and 1930s, the Institute for Theoretical Physics in Copenhagen, headed by Bohr commanded an influence over the world of scientific thought equaled only by Aristotle's Lyceum in Athens. Theoretical physicists went there from all over the world, during a time often called the heroic age of atomic physics."

Max Karl Ludwig Planck

Bohr's charismatic personality and his revolutionary contribution to physics drew the best young minds from all over the world. In this context it is interesting to quote what Otto Frisch had to say about Bohr : "He had a soft voice with a Danish accent, and we were not always sure whether he was speaking English or German; he spoke both with equal easy and kept switching. Here, I felt, was Socrates come to life, tossing us challenges on a higher plane, drawing wisdom out of us which we didn't know we had, and which of course we hadn't."

In 1916 Bohr introduced the concept of correspondence principle – the principle that quantum mechanics has a limit in which it is equivalent to classical mechanics. Thus this principle to some extent brings the new theory nearer to the classical physics.

It an attempt to reconcile quantum and classical physics — two equally plausible but mutually exclusive ideas – Bohr proposed his 'Complementarity Principle' in 1927 Bohr observed that a phenomenon can be visualised in two mutually exclusive ways, but at the same time both visualisations can remain valid in their own terms. For example, light may undulate like a wave in one instrument but it may scatter in another instrument. This means, Bohr argued, evidence obtained under different experimental conditions cannot be comprehended within a single picture, but must be regarded as complementary in the sense that only the totality of the phenomenon exhaust the possible information about the object. As Frisch pointed out "it is a bit as if reality was painted on both sides of a canvas so that you could only see one aspect of it clearly at any time". Together with the indeterminacy principle of Werner Heisenberg (1901-76) and the probability waves of Max Born (1882-1970), Bohr's complementarily principle has emerged as the most authoritative and widely accepted theory to describe atomic phenomena.

Max Born

Bohr's contribution in the field of radioactivity is quite significant. Bohr formulated the law of radioactive displacement. According to this law when radioactive element emits alpha particle it moves two places to the left on the Periodic Table (down in atomic number) but if it emits a beta particle, it moves to the right one place (up in atomic number). Bohr's liquid drop model of the nucleus proposed in 1936 provided the basis for the first theoretical account of fission worked out in collaboration with John Wheeler in 1939. It was Bohr who had first suggested that the fission was more likely to occur with the rarer isotope uranium 235 than the more common variety uranium 238.

Werner Heisenberg

Bohr played an important role in advancing the study of physics in Europe. The idea of establishing CERN (Counsel European pour la Recherche Nucleaire or European Council for Nuclear Research) took shape in a conference in Copenhagen in 1951. CERN is an international centre for theoretical and experimental physics. Contrary to Bohr's expectation CERN was located in Geneva and not in Copenhagen, though initially for some time the theoretical branch of CERN was located in Copenhagen. After CERN Bohr helped establish a theoretical physics consortium, called Nordita (Nordisk Institute Theoretisk Atomfysik). The idea was not to compete with CERN. Denmark, Norway and Sweden participated in the establishment of Nordita, Subsequently Finland also joined. Bohr was associated with the Denmark's Atomic Energy Commission since its inception.

Denmark was occupied by the Germans. Bohr, who had a Jewish mother, felt it necessary to escape from the occupied Denmark and eventually made his way to Los Alamos in the USA where he served as a consultant on the atomic bomb project. Bohr's son Aage Niels Bohr also worked here as a Junior Scientific Officer. By mere presence of Bohr, the project, 'which looked so macabre' seemed to be hopeful . To quote Weiskopf : "In Los Alamos, we were working on something which is perhaps the most questionable, the most problematic thing a scientist can be faced with. At that time physics, our believed science, was pushed into the most cruel part of reality and we had to live it through. We were, most of us at least, young and somewhat inexperienced in human affairs, I would say. But suddenly in the midst of it, Bohr appeared in his Alamos.

Aage Niels Bohr

It was the first time we became aware of the sense in all these terrible things, because, Bohr right away participated not only in the work but in our discussion. Every great and deep difficulty bears in itself its own solution… This we learned from him".

Most of Bohr's time after the war was spent working among scientists for adequate control of nuclear weapons. In 1955 Bohr orgainsed the first Atoms for Peace Conference in Geneva.

Bohr visited India in 1960 at the invitation of Indian Science Congress Association. He attended its session in Mumbai, where he delivered two lectures on human knowledge and atoms and on the principles of quantum physics. He also

Contd. on page 21

Recent Developments in Science & Technology

New Materials for Halogen Plasma Lamps

Researchers have developed new alumina materials for use in halogen plasma lamps that have greater efficiency in the form of clearer and brighter light.

Halogen plasma lamps perform better than conventional incandescent light bulbs of same power. They could have an even greater efficiency and longer life if it were possible to increase the pressure of the gas inside. But the pressure of the gas inside and the temperature the material used to make the envelope or bulb withstands are limited. Quartz glass and the types of ceramic materials commonly used but they are unable to cope with the high internal pressure. However, it has how been found that aluminium oxide, also known as alumina or corundum, is capable of withstanding such extreme conditions. This material does not melt below a temperature of 2000 degree centigrade.

This new alumina material has been developed as part of the STAR LIGHT project sponsored by the EU. The Fraurhofer Institute of Ceramic Technology and Sintered Materials in Dreseden is a major participant in this project.

New Scientist, July 2002

Biotech Breast Milk for Babies

Researchers hope that Genetically modified (GM) rice carrying a protein from human breast milk could be used to enhance infant formula. But at present the protein would not gain approval for use in any country.

Nutritionists agree that breast milk is best for a baby : Infant formula is not as nourishing as the real thing. So for mothers unable to breast–feed, the biotech industry is engineering crops or animals to make human breast milk protein to humanize formula.

Yuriko Adkins of the University of California, Davis and her colleagues, have modified rice plants to carry a human gene for a milk enzyme called Lactoferrin. Babies need this to use iron efficiency and fight infection. This milk have been fed to rats and found that this is useful to kill all harmful bacteria.

Nature June 2002

Camera that Works in Darkness and smoke

Fire fighters and others engaged in rescue operations find it difficult to perform their duties in darkness and smoke. However, their task will now be much easier with the launch of a light weight thermal imaging camera in India which is capable of seeing through darkness and smoke.

The thermal imaging camera has been designed by US company Bullard which has tied up with the Indian company Vijay Industry and Project Ltd. for its marketing in India.

This thermal imaging camera, which catches images on the basis of body temperature, has been designed by Bullard scientists according to needs of fire personnel. It is portable, lightweight, handy, and resistant to heat and water and can withstand shocks.

Another important aspect is that the camera is capable of wireless transmission to TV Monitor up to 10 metre of distance. If a rescuer goes to the site of a disaster, people outside can know of his location as well as of those who are trapped inside.

PTI News June 2002

Electronic Excitation on Metal Surfaces New Chemical Sensor

Santa Barbara and colleagues at the University of California made a new chemical sensor from a so called Schottky diode – a silicon wafer coated with a metal film only a one hundred - millionth of metre thick. The researchers detected excited electron produced by absorption of chemicals on diode surface. The sensor in turn captured the energized electrons and produced a measurable electrical signal, which is known as a chemicurrent.

The new setup differs from other types of thin-material currently in use, because it detects molecules directly instead of measuring indirect charges caused by the presence of a chemical. So a combination of sensors that operate over a wide range of temperature and are relatively inexpensive to produce could feasibly detect a variety of contaminates in a manufacturing environment.

Scientific American June 2002

Compiled by: Kapil Tripathi

Contd. from page....22

visited Kolkata, Chennai, Agra and Delhi. It is to be noted that the then Prime Minister of India Jawaharlal Nehru accompanied Bohr during these visits.

Bohr died on November 18, 1962. On his death the *New York Times* wrote : "With the passing of Niels Bohr the world has lost not only one of the great scientists of this century but also one of the intellectual giants of all time."

Books written by Niels Bohr

1. *The Theory of Spectra and Atomic Constitution*, Cambridge: Cambridge University Press; 1922.
2. *Atomic Theory and the Description of Nature*, Cambridge: Cambridge University Press 1934.
3. *The Unity of Knowledge*, New York : Doubleday & Co., 1955.
4. *Atomic Physics and Human Knowledge*, New York : John Wileys. 1958.

Books on Niels Bohr

1. *Niels Bohr : A Century Volume*. Edited by A.P. French and P.J. Kennedy. Cambridge, MA Harward University Press 1985
2. *Niels Bohr : The Man, His Science, and the World They Changed* by Ruth Moore. Cambridge, (Massachusetts) : MIT Press 1985.
3. *Niels Bohr's Times : In Physics, Philosophy, and Policy* by Abraham Pais. New York : Oxford University Press, 1991.
4. *Niels Bohr : His life and Work as Seen by His Friends.* Edited by S. Rozental. New York : John Wiley, 1967.
5. Niels *Bohr : Gentle Genius of Denmark* by Ray Spangenburg and Diane K Moser. Hyderabad : Universities Press (India) Limited 1999.
6. *Niels Bohr : A Profile* Edited by A.N. Mitra, L.S. Kothari, V.Singh, S.K. Trehan. New Delhi Indian National Science Academy, 1985.

• • •

Sedentary Lifestyle and Bone-related Ailments

An interview with Dr. R.K. Chopra

Dr. R.K. Chopra

Bones, the hard tissues that form the skeleton of human beings and other vertebrate animals, play an important role in providing shape and strength to their physical structure. Bones are made up mainly of an organic material called collagen and inorganic minerals such as calcium, phosphate and carbonate. In the very young, the skeleton is composed largely of cartilage and is therefore pliable, reducing the incidence of bone fracture and breakage in childhood. As the body grows older, decreases in bone mass may lead to an increased vulnerability to fractures.

There is a misconception that bones are made up of dead tissue. This is not true; they have cells, nerves, blood vessels and pain receptors. Bones assume a variety of sizes and shapes; however, all bone tissue has a three-layered composition. A spongy layer forms the interior. Long bones (such as those in the arms and legs) are hollow, the inner spaces being filled with marrow.

In tensile strength, bone is rather like cast iron, although it has half the weight of the latter. In bending stress, it behaves more like steel, but it is only half strong as steel. In compression, bones can withstand the forces exerted by a running man (equivalent to a dead weight of 270 kg).

Besides being a storehouse of calcium (97 per cent of calcium is stored in bones) and providing protection to a number of vital organs, muscles and nerves from external damage, bone acts as a lever and a holder of marrow, an important ingredient in the formation of blood cells.

Dr. R K Chopra, Associate Professor of Orthopaedic Surgery at Safdarjung Hospital and Vardhman Mahavir Medical College, New Delhi, talks to **Dream 2047** about the latest developments in orthopaedics, the study of bones. Excerpts from an interview with **Dr. Chopra**:

Dream 2047: An increasing number of accidents take place these days, say on road, rail or in industries. It has been one of the major health issues that medical practitioners have to grapple with. Has the changing lifestyle affected the ailments/diseases related to bones?

Dr. Chopra: Yes. Definitely. Not only has the number of reported accident cases gone up, even the extent and nature of fractures involved has also undergone a drastic change of late. For instance, most victims of road or rail accidents today suffer from multiple fractures, which in medical terminology we call high-velocity trauma. Such multiple fractures not only require treatments, which are complex and complicated, but also result in higher incidence of mortality and morbidity, if the medical care is not reached the victim at shortest possible time. The most important thing is to ensure that the disability is decreased. Now relatively perfect treatments are available and these can be accompanied by fracture fixation unlike conservative methods like traction and plaster of paris casting used in the earlier days. The sedentary lifestyle followed by a large number of people is leading to increasing cases of backache and spondylosis in our country. The factors that aggravate the situation in general are lack of exercise and bad posturing. Prolonged activities without adequate rest can also worsen the situation as seen in many very ambitious people who lead hectic lifestyles.

Dream 2047: Diseases like osteoporosis and arthritis are affecting a large number of people. What are the chances of reducing these debilitating ailments through proper nourishment and/or treatment? What are the other preventive measures available?

Dr. Chopra: Osteoporosis and arthritis (degenerative) are mainly age-related. Sedentary lifestyle too leads to osteoporosis. So is hereditary predilection. While less physical activity can lead to osteoporosis at a later stage in life, arthritis is generally caused by the wear and tear of joint cartilage. In the case of osteoporosis patient, the bone mass per unit volume tends to be less. This makes the person prone to bone fractures. The quality and texture of the bones of the patient is so poor that there is an increased chance of having generalised bone fractures – especially vertebral (spinal) and hip fractures. This will demand an active attention in order to prevent recurring episodes of fractures. A young female in the age group of 25-35 has a bone mass loss of 0.3 per cent per annum. A decade after the menopause the loss is up to the extent of 3% per annum, leading to higher turnover and disruption of the formation-resorption equilibrium of the bone mass. This sets off the process of weakening of the bones which is far more than normal deletion, a very slow process. Those who consume alcohol, smoke, those who are on prolonged cortico-steroids, those suffer chronic renal diseases, and who undergo surgical histeroctomy that leads to pre-mature menopause are more prone to osteoporosis.

A person who has a high risk of osteoporosis will require an additional quantity of 1500 mg of calcium in addition to that contained in normal diet. While sunlight can provide adequate quantity of vitamin D, egg, milk, fruits — both fresh and dry — and vegetables have plenty of calcium. Exercises such as brisk walking, jogging, cycling and swimming as well as increased physical activity in general are also very important. One should try to add as much bone mass as possible before he or she attaubs an age of 35 through proper dietary care and increased physical activity. Hormonal imbalances and metabolic disorders too contribute to osteoporosis. Women in general will have hormonal imbalances in the post-menopausal period due to decreased estrogen levels. This can be taken care of through hormone replacement therapy (HRT). There

are several drugs too available for correcting hormonal imbalances. Among osteoporosis patients, bone pain and lower backache are the main symptoms. History of any trivial trauma should also be watched for. Densitometry tests, which are available nowadays, can determine loss of bone mass quite accurately.

There are many causes for arthritis. But the main one is age-related degeneration of joint cartilage which is more commonly seen in the knee and hip joints. This leads to painful, stiff and deformed joints and hence hampers day-to-day physical activities, particualrly squatting and climbing stairs, etc. There is a familial or hereditary predisposition to arthritis. The severity of the disease can be prevented by optimally utilising joints throughout the life and by taking care of pre-disposing factors such as obesity. Controlling diabetes and osteoporosis is also important for the management of degenerative arthritis.

Dream 2047: Fluorosis, caused mainly by the long-term consumption of water containing fluorides, is believed to be a major health problem among Indians. How serious is its manifestation? How does it affect the bones?

Dr. Chopra: In certain areas in the country, particularly in Rajasthan, Haryana and Tamil Nadu, fluorosis is a problem. But fluorosis is highly endemic. Generally, the bones are not affected by fluorosis. A person, affected by fluorosis, has weaker bones, though they look more dense on the X-rays. At the same time, in many fluorosis cases, the spinal column is seen to be affected. The flourides clog the spinal column affecting the transmission of signals to the lower portions of the body, leading to weakening of upper and lower limbs. In addition, fluorosis, very commonly affects the enamel of the teeth.

Dream 2047: It is widely believed that once a bone is broken, there is every possibility that it would remain weak throughout the life, even after proper healing. Is there any truth in it?

Dr: Chopra: This is not at all correct. This is because there is a constant remodelling process happening all the time. If the fracture is properly treated, it will be even difficult to find out where the fracture was after two years. After the complete remodelling, the fractured bone will be comparable to a normal bone in strength.

Dream 2047: How can one keep one's own bones healthy?

Dr. Chopra: As I told you earlier exercises and high level of physical activity are very important. And sedentary lifestyle should be avoided. It is important to have sufficient exposure to sunlight. Adequate quantities of milk, egg, fruits and vegetables should be taken in diet. In the case of lactating mothers, growing children and older people a little calcium can be added extra. Smoking and alcohol should be strictly avoided.

Dream 2047: Can you please tell us about some of the major developments that have taken place in orthopaedics in the recent times? How have they helped improve the lot of the common man?

Dr Chopra: Total joint replacements are commonly done today. They are showing good results. The improvements in techniques and in quality of implants have helped in increasing the success rate. New surgical practices such as endoscopic and arthroscopic surgeries are being increasingly used particularly to cure sports-related injuries, where immediate and complete recovery is the requirement. These techniques not only help in lessening the trauma of patient, but significantly reduce hospital stay. And thus helps the patient to be up and about at the shortest possible time.

Another area where significant improvement has happened in the last few decades was in treating spinal cord injuries. While spinal cord injuries used to be very debilitating till very recently, now major advancements in spinal surgery and rehabilitatory care have helped reduce the morbidity and disability of patients with spinal cord injuries. External fixators available today are ensuring efficient and better treatment of wounds associated with fractures. Also everyone knows how Russian doctor Ilazarov's techniques have revolutionised the treatment of different types of complicated bone losses and limb shortenings, etc.

Dream 2047: What precautions need to be taken while rushing an accident victim with suspected bone injuries to a hospital?

Dr Chopra: Medical assistance should be reached the patient in the shortest possible time. The location of fracture should be identified and that part should be immobilised using either splints or any other suitable material. If a fracture suspected in one of the lower limbs, both the legs of the patient can be tied together in order to immobilise the affected limb. Also, it is very very important to find out whether there is any spinal injury. If the victim complains of any backache or weakness in the limbs, there is a possibility of having a spinal injury. Such victims should be put on the stretcher gently with the help of at least three people. This will ensure that there would not be a further damage to the spinal cord while moving him to the nearest medical centre.

Dream 2047: There have been a lot of misconceptions about long-term adverse impact of using metallic and ceramic implants for managing fractures. Can you please throw some light on them?

Dr. Chopra: Such fears have absolutely no basis. Implants nowadays used for medical applications are inert and hence are absolutely safe. Since they are biologically inactive, they generally do not create any complications like corrosion etc. In fact, there are many implants that are left inside the body life-long. Thanks to advances in modern metallurgy, surgical implants available today are of high quality. They are used both as permanent replacement as well as for fixative purposes.

❒ **T V Jayan**

• • •

History of Cholera

❒ Dr. P.K. Mukherjee

Robert Koch not only spotted out the anthrax bacilli and bacilli of tuberculosis but was also instrumental in discovering *vibrio cholerae,* the bacilli responsible for causing cholera.

The comma-shaped microbes

In 1883, when cholera was wiping out human lives in Egypt, Koch with his companion Gaffy arrived there. Both installed themselves in an ill-equipped, ill-ventilated laboratory. In the sweltering heat of Alexandria both toiled without respite, dissecting endlessly the carcasses of cholera victims. However, as the fate would have it, without any visible indication the epidemic suddenly died away. This greatly disappointed Koch. But, he had by then hundreds of specimens ready with him. On returning to his homeland, Koch separated the specimens and commenced a tireless search with the aid of the microscope. Surprisingly, in each specimen he found the same curved and comma-shaped microbe.

S.N. De

Koch decided to proceed to India, the home of cholera epidemics, to carry out further investigations. After having secured the permission from the Minister of State, Koch sailed for India.

Koch's only friends on board the ship throughout the journey, the confidants of his secret thoughts, were the mice and the guinea pigs he was carrying with him for varied tests in India.

He landed in Calcutta in 1884 where the epidemic was raging. Koch found the same comma-shaped bacilli in hundreds of carcasses of cholera victims that he dissected.

Koch was convinced that he had traced the murderer. But, his scientific conscience would not accept the conclusion until he had raised cultures of comma microbes on beef-broth jelly.

Koch closely studied their birth, their death, the congenial surroundings they prefer and the way they die. There was no doubt left. It was the comma bacillus that was instrumental in infecting the healthy people through the soiled linen of cholera victims or through polluted waters of lakes and rivers.

After reaching Berlin Koch submitted his report, which read: 'Cholera never rises spontaneously. No healthy man can ever be attacked by cholera unless he swallows the comma microbe, and this germ can only develop from its like; it cannot be produced from any other thing, or out of nothing. It is only in the intestines of man, or in highly polluted waters that it can grow.

The scientific world of Germany felt jubilant and proud over Koch's fresh success. The German Emperor bestowed on him the highest emblem or honour, the *Order of the Crown.*

Cholera Pie
Caricature by Cruikshank suggesting that doctors thrive on cholera

Cholera : An overview

Cholera is a water-borne disease caused by *vibrio cholerae,* the comma-shaped bacilli. The cholera germs enter the body of a victim through the contaminated water he drinks. However, the germs can also enter the body through infected food. Therefore, one must carefully cover the food and eatables so that flies and cockroaches, etc., which may be the carriers of the germs, are prevented from squatting on them. Also, drinking water and water used for washing plates, dishes, etc. should preferably be boiled. This precaution is specially important during the summer months when one notices an increase in the cholera and gastroenteritis cases.

The term cholera was often used as early as 400 B.C. to describe acute intestinal disorders. In India, cholera has been present since antiquity. Mention of cholera as 'vishuchika' appears in Ayurveda. Reference to cholera can also be found in the *Susruta Samhita* of the 7th century B.C. which clearly defines the disease.

Before 1961, the cholera vibrio was of the classical variety. However, in 1961 a new variety, called vibrio el tor made its appearance in the Celebes island of Indonesia. The el tor biotype of V. cholerae reached India in 1964.

The pandemic that began in 1961 in Indonesia was seventh in the row. Six pandemics were earlier reported to have erupted during the period 1817-1923. Strangely, five out of these six pandemics were considered to have originated from India. The period 1871-1923 marks the second phase in the history of cholera. The first phase pertained to the period prior to 1817 during which the disease was confined to the East, if not almost exclusively to India. The third phase spanning the period 1923-1960 saw the disease retreating from the European countries and once again becoming a disease of the East, particularly the Asiatic countries. The disease then came to be known as 'Asiatic Cholera'. The world at present is in the grip of the seventh pandemic which continues to spread its tentacles.

It may be mentioned that the El Tor biotype of V. Cholerae was first isolated in 1905 at the El Tor quarantine station in Egypt. Classical and el tor vibrios are further divided into three serological types viz. Imaba, Ogawa and Hikojima. It may be noted that most of the el tor vibrios isolated in India belong to the Ogawa serotype.

Cholera is a diarrhoeal disease in which rice-water like stools usually coupled with vomiting are discharged. The loss of mineral salts and water from the body leads to dehydration. The patient may also suffer from the symptoms of abdominal muscular cramps and may complain of urine suppression. Unless the patient is rehydrated by the rapid replacement of fluid and electrolytes, he may suffer from kidney failure and circulatory collapse which may eventfully lead to his death.

The discovery of the classical cholera vibrio was made by Robert Koch in 1884. who suggested the possibility of the existence of a cholera poison which produces the ill-effects of the disease. According to Koch, the poison was absorbed by the circulatory system of the patient and paralysed it.

Until 1958 it was believed that cholera was the result of an endotoxin, that is, poisonous substance present in the cholera bacteria and released from it only after the bacterial cell was disintegrated. However, in 1958, 75 years after the discovery of cholera vibrio, the Indian investigator S.N. De discovered the exotoxin (enterotoxin) responsible for the ill-effects of the disease. De used the rabbit ileal loop technique for making his pathpreaking discovery of the cholera exotoxin. It may be noted that an exotoxin is a soluble poisonous substance produced by bacteria during their growth and metabolic action, and released into the surroundings.

The cholera exotoxin activates a substance, called adenyl cyclase, in the intestinal epithelial cells. The activated adenyl cyclase causes a rise in another substance called cyclic or

Contd. on page.....17

Koch, however, remained very modest. When asked to comment on his success, he said: 'I have labored as hard as was permitted to me. If my success has been more apparent than that of others, the reason is that I came across regions where gold was still lying by the wayside during my wandering in the fields of medical science. That is luck, and no great merit on my part.'

Pettenkofer

Koch had found the comma-shaped bacilli in the stools of only cholera patients. So, he felt bold enough to assert one deduction – the absence of the comma bacilli in a stool was a trustworthy indication for declaring it non-choleric.

The comma bacillus, discovered by Koch, is a very tiny microbe, which is the half the length of the tubercle bacillus. It is curved like a comma and has peculiar habits. It detests distilled water; but thrives in salt water. Although in milk it multiplies at an enormous rate, it is however unable to curdle it.

Metchnikoff

The post-mortem examination of cholera victims carried out by Koch showed marked effects produced by disease. The victims' lungs had become dry, shrunken and anemic. While their pulmonary arteries were distend with blood, their pulmonary veins were empty. Their livers got loaded with blood; the spleen became small and shriveled; and the gall bladder was found to be saturated with bile. Inside the bowels of the victim could be found a large quantity of the rice-water like liquid seething with bacilli.

The controversy

After Koch published the results of his discovery a great controversy arose. Many scientists refused to accept the comma bacillus as the only cause of cholera. One of them was a Munich-based scientist, professor Pettenkofer. He was a strange and eccentric scientist who believed that the disease arises in the soil from chemical fermentation, the cause of which is accidental and unknown. He openly scoffed at Koch's latest discovery. Not only that, he even challenged Koch to send him his most virulent comma germs. On receiving the same from Koch, Pettenkofer, without a moment's hesitation, swallowed the whole of it, which was packed in a tube.

The contents of that one tube were enough to wipe out a whole city. It Koch's theory was infallible, there was certain death–an agonising painful death–in store for Pettenkofer. However, strangely enough, Pettenkofer survived. Nothing serious happened to him except that he suffered from minor stomach ailments. He growled loudly at Koch: 'Germs are of no account in cholera. It is the disposition of the individual that matters. Your see I am alive in spite of your poisonous germs!'

Cholera bacilli

Scientific searchers have wrangled for a long time about this Pettenkofer miracle. However, it seems that science so far has not been able to find a convincing answer.

Contd. from page.....18

CAMP which provides energy that drives the fluid and ions into the lumen of the intestine. The increase in fluid is the cause of diarrhoeal symptoms of cholera. There is, however, no evidence to the fact that the cholera exotoxin invades any tissue of directly affects any organ other than the epithelial cells of the small intestine.

For prevention of cholera, vaccines are available. The vaccine employed at present is a saline suspension comprising approximately 6000 millions each of classical ogawa and Inaba serotyper of V. cholerae per millilitre so that each millilitre of the vaccine contains a total of 12,000 million vibrios. The organisms are killed and preserved by the addition of 0.5 percent phenol. The vaccine protects equally well against the el tor infection.

However, in recent years, doubts have been raised about the usefulness of cholera vaccine as a preventive measure. Therefore, they are advised to be used only as an adjunct to other preventive measures such as drug prophylaxis, sanitation and health education. International research work is in progress toward the development of more potent cholera vaccines.

Metchnikoff, a scientist of renown, also followed suit by swallowing a pure culture of the cholera vibrio. But, he was not as lucky as Pettekofer. While he was mocking at the ravages of the disease, death suddenly peeped inside his laboratory, and in the twinkling of an eye, he was lying by the side of his ancestors in his grave.

Buchner, another scientist of established reputation, supplied a plausible explanation of the 'erratic' behaviour of the comma bacillus. He suggested that probably some second, and as yet unknown, microbe–too tiny to have been spotted so far–must accompany the cholera vibrio in order to cause the disease in its virulent form.

However, the speculations of these scientists have all proved to be wrong. Repeated experiments now show that the comma bacillus varies its virulence without notice and without an ostensible cause. Indeed, the comma bacillus seems to be a mystery par excellence for the scientist, for it has been known to vary its intensity as high as one to five hundred.

Cholera being a water-borne disease preventive measures against it are very necessary. However, anti-cholera inoculations may temporarily give immunity against the disease. It may be interesting to be seized of the history of the inoculations.

History of cholera inoculations

In 1885 when Spain was ravaged by a cholera epidemic, for immunising people Ferran injected them with pure cultures of cholera vibrio, which he obtained from cholera corpses. However, he failed to control the virulence of the cultures he used for his injections. On the principle that poison is the best antidote for poison, Ferran often succeeded. But, he was not able to cure every time.

In 1893, Haffkine improved on Ferran by using a pure culture of a fixed and known strength. In 1895, with the active support of the Government of India, he tried his 'mild' vaccine on nearly 50,000 individuals. The microbes Haffkine injected soon died inside the body of the individual, at the same time releasing substances on their death which gave immunity against cholera.

• • •