ISSN : 0972-169X
Registered with the Registrar of Newspapers of India: R.N. 70269/98 Postal Registration No. : DL-SW-1/4082/2006

Monthly Newsletter of Vigyan Prasar

DREAM 2047

July 2006 Vol. 8 No. 10 Price: Rs. 5.00

VP News

State Level Ham Radio Training Programme in Uttaranchal

A state level ham radio training programme was organized by Vigyan Prasar at Dehra Dun jointly with the Uttaranchal State Council for Science & Technology (U-COST) and National Service Scheme (NSS), Uttaranchal, from June 7 to 29, 2006.

Uttaranchal being in a highly seismic zone, this effort was initiated to impart radio communication skills to the NSS volunteers and to set up a ham radio communication network for emergency communication. Fifty-two Programme Officers and volunteers of the National Service Scheme (NSS) from thirteen districts of Uttaranchal were trained for the Amateur Radio Licensing examination.

NSS volunteers listening to ham radio transmissions during a demonstration programme

The training programme was inaugurated on June 7 by Dr. Rajendra Dobhal, Director, U-COST. Dr. V.B. Kamble (VU2VBK), Director, Vigyan Prasar and Shri B.K. Tyagi, Scientist 'D', Vigyan Prasar attended the inaugural ceremony as special guests. Shri Sandeep Baruah (VU2MUE), Scientist 'C', Vigyan Prasar was the main resource person during the entire training period. A few hams from

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Workshop on Innovative Experiments in Physics

A two day workshop on 'Innovative Experiments in Physics' was held at Army Public School, Lucknow on 30 and 31 May, 2006. The workshop was inaugurated by Prof. V.D. Gupta, former Vice Chancellor of Allahabad University. Ms K. Dasgupta Misra, Vigyan Prasar welcomed the participants and made a presentation on Vigyan Prasar and its activities. The workshop was attended by more than 35 teachers of physics from various districts of U.P. The participants were from Varanasi, Allahabad, Lucknow, Kanpur, Gorakhpur, Jaunpur, Barabanki, and so on. After the inauguration, the demonstration of innovative experiments in Physics was shown by Shri Mukesh Roy of IIT, Kanpur. More than twenty five innovative experiments in Physics were demonstrated to the participants. Teachers appreciated the workshop and

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Teachers participating in the workshop

Inside

... 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 S. Narayan & Sons, B-88, Okhla Indl. Area, Phase - II, New Delhi - 110 020
Editor : Dr. V.B. Kamble

The Beautiful Game

Throughout history, some form or the other of a kicking game has been played by human beings. Indeed, the beginnings of football date back to 2500 BC, with the Chinese kicking game *tsu chu*. Similar games were played by Romans and the North American Indians. English mob football was immensely popular, but was too violent. It was outlawed some five times by the medieval kings! What is called the association football today (or "soccer" from the abbreviation of the word "assoc.") evolved in medieval Britain. British sailors and merchants took the game to the farthest corners of the world. The instant acceptance of the game was due to its simple formula – a ball and imagination. Today the game is played in almost every nation of the world with more than 120 million regular players!

For the past one month, beginning from 9 June 2006, the attention of the world had narrowed down to football, to those magnificent men, and their beautiful game. With 32 elite teams from all over the globe and 64 matches transmitted live to all parts of the world, day in and day out, the World Cup 2006 simply couldn't be ignored. It enthralled millions across the globe with a game that has a universal appeal. And why not? Indeed, football's universality is its simplicity. Football is probably the simplest of all games in the world – and simple is beautiful. You only need a ball and can play in a street! You do not need a ground, nor do you need a specially manufactured Adidas ball to play with. You can play the game anywhere with anything. Even a ball made of rags and wrapped around rags would do! At least that is how I played football in my childhood in the non-descript town of Junagadh in Gujarat!

Alas! India was nowhere on the World Cup map. Trinidad and Tobago was the smallest nation in the World Cup 2006, both in terms of population (just 1.3 million) and size (only about 5,100 square kilometres). Africa sent four nations – Angola, Ghana, the Ivory Coast and Togo – some of the poorest and smallest nations in the world! How is it that the resurgent India cannot send a team to the World Cup? It is often argued that Indians cannot compete in such power games due to their small stature. But then, physical dimensions of Africans or Japanese are no different from that of Indians! Then, is it due to poverty? To answer this question, let us consider how big Togo's economy is. Its growth rate in 2005 was just 1% and GDP about two billion dollars. Incidentally, GDP (Gross Domestic Product) implies the value of all final goods and services produced within a nation in a given year. Ivory Coast had the same non-growth rate, and a GDP of $16.5 billion. Ghana was in single figures as well, with a GDP of $9.4 billion and a growth rate of 4.3%. How about India? India's GDP is $775 billion and growth rate 7.6%; and a population of a billion plus. The population of some of these countries could compare with that of an Indian district! The entire Togolese population could be fitted comfortably into a suburb of Delhi or Mumbai. Needless to say, poverty and size of a country are of no consequence. There is enough wealth to create world-class teams in any sport.

India's current FIFA ranking is 117 after Palestine and Hong Kong! But, it was not always so. For almost a decade, from 1951 to 1962, India was counted as one of the best football playing Asian nations and even won the Asian Games Gold in 1951. India even reached the Olympic football semifinals in Melbourne in 1956. Then we fell into a swamp. In the period that followed, other nations in Asia and Africa – that did not even exist on the sports map of the world – put sweat into their skills and passion into their dreams. Today we are *smaller* than even Trinidad and Tobago! Surely, it is not money that matters. What matters is will and patriotic spirit.

In India, the challenge is to popularize football as a domestic game and attract greater participation and inculcate interest. In the next stage, it would be necessary to initiate a vibrant professional league and player development programme. Next, only the professionals should be at the helm of affairs in the Indian sport. Also required would be commercial partners and media for promoting the game and enhancing awareness. Then the football fans of our country shall not be mourning Brazil's defeat to France in the World Cup more than the Brazilians themselves!

Pelé, Diego Maradona, Zinedine Zidane, Ronaldo, and Ronaldinho have been the living legends of football, inspiring millions all over the world. Many of them have risen from poor families. There is no gainsaying the fact that we already have many such legends in Science and Technology in India. As in sports, we shall need commercial partners and media for promoting and popularizing Science and Technology. That such partnership is possible in science

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Marie-Sophie Germain

The Remarkable Woman Mathematicians of France

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"All things considered she (Sophie Germain) was probably the most profoundly intellectual woman that France has ever produced. And yet, strange as it may seem, when the state official came to make out the death certificate of this eminent associate and co-worker of the most illustrious members of the French Academy of Science, he designated her as a "Rentiere-Annuitant" (a single woman with no profession)…Nor this all. When the Eiffel Tower was erected, in which the engineers were obliged to give special attention to the elasticity of the materials used, there were inscribed on this lofty structure the names of seventy-two savants. But one will not find in this list the name of that daughter of genius, whose researches contributed so much toward establishing the theory of elasticity of metals – Sophie Germain. Was she excluded from this list for the same reason that Agnesi was ineligible to membership in the French Academy – because she was a woman? It would seem so."

H. J. Mozans, an historian and author of Women in Science (1913)

Sophie-Marie Germain made great contributions to the number theory, acoustics and elasticity. Sophie's education was disorganised and haphazard. She never received any professional training in any subject. She was not associated with any institution because she was a woman and in those days in France women were not allowed to study in academies. She thrived in complete intellectual isolation. She happened to be the first woman not related to a member to attend the sessions of the French Academy of Sciences. She was also the first woman to be invited by the Institute of France (Institut de France) to attend its sessions. She was successful in making partial progress on a proof of Fermat's Last Theorem [named after the French mathematician Pierre de Fermat (1601-1665) regarded as founder of the modern theory of numbers]. Germain mathematically solved the problem of Chladini figures – patterns produced by vibrations. Her work was considered very important in the field of newly emerging field of mathematical physics, especially to the study of acoustics and elasticity.

Marie-Sophie Germain

Marie-Sophie Germain was born on 1 April 1776 in Paris, France to Ambroise-François and Marie-Madelaine (*nee* Gruguelin) Germain. Germain's father was a silk merchant. He later became a director of the Bank of France. In her home Marie-Sophie Germain was simply called Sophie. The family home of the Germains was a meeting place for liberal-minded people for discussion on political and philosophical issues. This gave an opportunity to Sophie to be familiar with these issues at an early age.

When Sophie was 13 years old, the French Revolution began. To protect her from the dangers caused by the revolution in Paris, she was confined to her home. Sophie had nothing to do. So to escape from the boredom caused by the complete isolation from the outside world, she took refuge in her father's extensive private library. Her reading certainly helped her to fight the boredom. But the most important thing was that reading became her passion. Sophie was greatly influenced by a book describing the story of Archimedes' life. She was particularly moved by an account of the death of Archimedes at the hands of a Roman soldier given in the book. It was said that during the Roman invasion of his city Syracuse, Archimedes was so preoccupied with the study of geometric figures in the sand that he failed to respond to a question put by a Roman soldier. The Roman soldier got annoyed and killed Archimedes. It may be noted that Roman soldiers had specific instructions not to kill Archimedes. The soldier certainly did not recognise Archimedes. There are different accounts of the episode. However, this particular account made Sophie deeply interested in mathematics. She thought if someone could be so engrossed in a mathematical problem that he would forget to respond to an invading soldier and die for it then mathematics must be really an interesting subject.

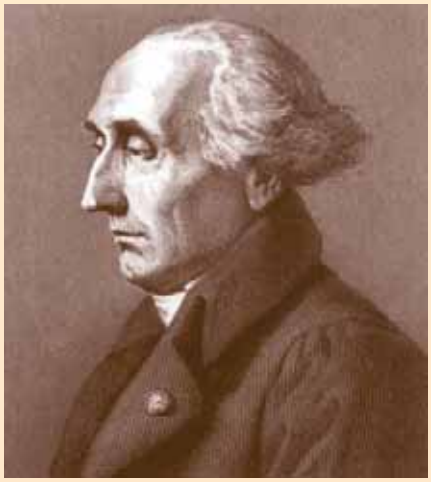
Sophie started reading each and every book on mathematics that she could find in her father's library. Her parents were very much disturbed to find out her interest in mathematics. In those days the existing social

norms did not encourage a female to pursue this kind of interest. In fact it was considered totally inappropriate. So her parents did everything that they could do to discourage her. When they came to know that she was studying at night to escape their attention they resorted to harsh measures to prevent her doing so. They took away her clothes once she was in bed. They also stopped providing heat and light in her room. All these harsh measures were to ensure her staying in bed and not to venture to study at night. But these measures failed to realise the desired objective. Sophie, to the utter dismay of her parents, managed to study mathematics at night. She would steal candles and keep them hidden for the night. In the absence of her clothes she would wrap herself in bed cloths and study by the light of the stolen candles. When her parents realised that it was impossible to dissuade her from reading mathematics they reluctantly allowed her to pursue her interest. Sophie spent the years of the Reign of Terror unleashed by the Revolution confined to her home and she fully utilised the time by studying mathematics on her own.

Pierre de Fermat

Sophie did not marry and devoted her entire life to the study of mathematics and science. Her father, initially discouraged her efforts to study mathematics, but supported her financially throughout her life.

In 1794, the Ecole Polytechnique, an academy to train mathematicians and scientists, was established. At the time Sophie was 18, a right age for admission to the academy. However, she could not enter the academy, not because she was not qualified but because she was a woman. In those days in France, women were not allowed to study at the academy. Had she been a member of the aristocracy her passion for mathematics might have been more acceptable. She could have at least studied privately at home. In those days in France it was acceptable for aristocratic women to be taught science in their homes with the help of tutors. This concession was made so that, if necessary, they would be able to participate in discussions on such subjects at social gatherings. Sophie's parents were wealthy but they were not aristocratic.



Joseph Louis Lagrange

Sophie was determined to study mathematics. Somehow she was able to obtain the lectures notes for several courses taught at the Ecole Polytechnique. She could manage to get the lecture notes by assuming a pseudonym, M. LeBlanc. There was a student at the academy named Monsieur Antoine-August LeBlanc. He had left Paris. However, the authorities of the academy were not aware that the real LeBlanc had left Paris. So they continued to print lecture notes and problems for LeBlanc. In any case for her there was a genuine reason for using a pseudonym of a male student for corresponding with the professors of the academy. Otherwise there was every reason that no professor would have taken her correspondence seriously because of her gender. In fact there was every reason to believe that she would have been ridiculed for studying mathematics.

Anyway, by adopting this means, irrespective of whether she was right or wrong, she became familiar with the teachings of several prominent French mathematicians. She started sending her comments to professors at the Polytechnique and at times original notes on mathematical problems. She immediately became fascinated with the teachings of Joseph Louis Lagrange (1736-1813). At the end of Lagrange's lecture course on analysis Sophie submitted a research paper. The originality and insight of Sophie's paper impressed Lagrange and he decided to look for its author. There was also another reason for attracting Lagrange's attention to Sophie's paper. The real LeBlanc was very poor in mathematics. So Lagrange wanted to know how this student got transformed himself into a brilliant mathematician. So he requested a meeting with the student. There was a real surprise for Lagrange. He found out that "M. LeBlanc" in reality was a woman and not a man as the name indicated. However, this revelation had no impact on his respect for her work. It remained so for ever. Lagrange became her mentor and helped her in her mathematical studies. He introduced her to the most famous mathematicians and scientists of France of that time. This opened a whole new world for her. It may be said that without Lagrange's support Germain would have never realised her ambition for pursuing the study of mathematics because of her social status and lack of professional training.

Carl Freidreich Gauss (1777-1855) published his monumental work, *Disquisitiones Arithmeticae,* in 1801. This was the most important and wide-ranging treatise on the subject since Euclid's *Elements*. Germain was

greatly inspired by this work. She started a correspondence with the author of her favourite book in mathematics in 1804. Gauss was one year younger than Germain. Both of them were in their twenties when they started corresponding. However, Gauss had already attained a European reputation in mathematics. Germain did not know Gauss' age and she was not sure how this great man would react to her correspondence. Like in earlier cases she used the pseudonym of M. LeBlanc for corresponding with Gauss and was greatly profited. She greatly admired Gauss' works. In her first letter to Gauss, Germain wrote: "For a long time your *Disquistiones Arithmaticae* has been an object of my admiration and study. The last chapter of this book includes, among other remarkable things, the beautiful theorem... Nothing equals the impatience with which I wait the sequel to this book I hold in my hands.

Carl Friedrich Gauss

I have been told that you are working on it at the moment. I would spare nothing in order to procure it as soon it appears." It seems that Sophie was almost in awe of Gauss' eminence. In one of her letters to Gauss she wrote: "Unfortunately, the depth of my intellect does not equal the voracity of my appetite, and I feel a kind of temerity in troubling a man of genius when I have no other claim to his attention than admiration necessarily shared by all his readers." Gauss encouraged her, though he was not aware of her true identity. He once wrote to her: "I am delighted that arithmetic has found in you so able a friend."

Sophie Germain found herself in such a situation that she herself had to reveal her true identity to Gauss. During a war Sophie was concerned with the safety of Gauss. Perhaps she never forgot the episode of the killing of Archimedes by an invading Roman soldier. She had requested one of her acquaintances named M. Penerty, who was in the army, to inquire about Gauss. M. Penerty had no knowledge that Germain was corresponding with Gauss as a man and not a woman. So while meeting with Gauss, M. Penerty revealed her true identity. Germain wrote: "In describing the honourable mission I charged him with, M. Penerty informed me that he had made known to you my name. This had led me to confess that I am not as completely unknown to you as you might believe, but fearing the ridicule attached to a female scientist, I have previously taken the name of M. LeBlanc in communicating to you those notes that, no doubt, do not deserve the indulgence with which you have responded. The appreciation I owe you for the encouragement you have given me, in showing me that you count me among the lovers of the sublime arithmetic whose mysteries you have developed, was my particular motivation for finding out news of you at a time when the troubles of war caused me to fear of safety; and I have learned with complete satisfaction that you have remained in your house as undisturbed as circumstance would permit."

Gauss was surprised to know that M. LeBlanc, with whom he had been corresponding, was in reality a woman. However, he was appreciative of Germain's interest in mathematics. Gauss wrote: "How pleasant and heart-warming to acquire a friend so flattering and precious. The lively interest you have taken in me during this war deserves the most sincere appreciation...Happily the events and consequences of war have not affected me so much until now, although I am convinced that they will have a large influence on the course of future life. But how I can describe my astonishment and admiration on seeing my esteemed correspondent Monsieur Leblanc metamorphosed into this celebrated person, yielding a copy so brilliant it is hard to believe? The taste for the abstract sciences in general and, above all, the mysteries of numbers is very rare; this is not surprising, since the charms of the sublime science in all their beauty, reveal themselves only to those who have the courage to fathom them. But when a woman, because of her sex, our customs and prejudices, encounters infinitely more obstacles than men, in familiarising herself with their knotty problems, yet overcomes these fetters and penetrates that which is most hidden, she doubtless has the most noble courage, extraordinary talent and superior genius. Nothing could prove to me in a more flattering and less equivocal way that the attractions of that science, which have added so much joy to my life, are not chimerical, than the favour with which you have honoured it. The scientific notes with which your letters are so richly filled have given me a thousand pleasures. I have studied them with attention and I admire the easy with which you penetrate all branches of arithmetic, and the wisdom with which you generalise and perfect it."

Ernst F F Chladini

This letter also contained three theorems on cubic and biquadratic residues developed by Gauss. He did

not include the proofs because he did not want to deprive Germain of the pleasure of finding them herself. Germain succeeded in solving the theorems in about a month. Gauss had developed a respect for Germain. Gauss' main interest was in number theory. In those days there were very few in Europe who could really understand his work in number theory. Germain was one of those few who understood Gauss' work. So it was natural that Gauss enjoyed her correspondence. For Germain, Gauss's letters were a great intellectual support in carrying out mathematical researches on her own.

Napoleon Bonaparte

In 1808, the German physicist Ernst Florenz Friedrich Chladini (1756-1827) visited Paris where he conducted experiments on vibrating plates, exhibiting the so-called Chladini figures. Small glass plates when covered with sands and bowed like a violin produced curious patterns. The sand moved about until it reached the nodes. This was the first experimental demonstration of two-dimensional harmonic motion. There was no mathematical explanation for the seemingly strange phenomenon. The French Emperor Napoleon was very much intrigued by the demonstration. At his instance, the French Academy of Sciences announced a big prize for finding out a mathematical solution. Most of the mathematicians did not attempt to solve the problem, mainly because one of their most illustrious members, Lagrange had said that the mathematical methods available at the time were inadequate to solve it. There was a genuine reason for this kind of assertion. At that time it was believed that molecular structure theorised for materials had to be taken into consideration for finding out an explanation of this kind of phenomenon. However, the mathematical methodologies appropriate to the molecular view could not cope with the problem. Germain attempted to solve the problem and she submitted her solution. In fact she was the only entrant in the contest in 1811. While her approach was in the right direction, it contained a number of mathematical flaws. She was not given the prize but the time period for the contest was extended. Eventually she was awarded the Prize.

Jean Baptiste Joseph Fourier

The prize from the Academy greatly helped her in drawing attention of the prominent mathematicians of the time to her work. She was allowed to attend the sessions of the French Academy of Sciences. She became the first woman to do so without being related to a member of the Academy. It became possible because of the initiatives taken Jean Baptiste Joseph Fourier (1768-1830). The Institut de France recognised the importance her contributions and they invited her to attend their sessions. This happened to be 'the highest honour that this famous body ever conferred on a woman.' This was a very important achievement in establishing Sophie Germain as a professional mathematician. Her paper would later become one of the foundations of the modern theory of elasticity.

Germain was much known for her work on Fermat's Last Theorem. She became fascinated in particular with Fermat's Last Theorem. We know that the famous Pythagorean theorem can be expressed in the form of mathematical equation, $x^2 + y^2 = z^2$. For this equation there are many whole number solutions, for example, $3^2 + 4^2 = 5^2$; $5^2 + 12^2 = 13^2$; $6^2 + 8^2 = 10^2$; $24^2 + 7^2 = 25^2$; and so on. Pierre de Fermat, the French mathematician posed a challenge for future generations of mathematicians by posing a question that when n is greater than 2 there is no whole number solutions for the equation, $x^n + y^n = z^n$. This is what is called Fermat's Last Theorem. Fermat himself had claimed that he had solution but he never published it or privately written it down. By varying the value of n you can get an infinite number of solutions. Some examples are given below:

$$x^3 + y^3 = z^3$$
$$x^4 + y^4 = z^4$$
$$x^5 + y^5 = z^5$$
$$x^6 + y^6 = z^6$$

This series of equations goes on infinitely. This is where the difficulty lies in solving the Fermat's Last Theorem. There can be not only an infinite number of equations but also an infinite number of possible values for x, y, and z. So to prove Fermat's Last Theorem one has to prove that there is no solution 'within this infinity of infinites'. Fermat's Last Theorem was one of the vexing problems in the history of mathematics. In early years the only progress that the mathematicians made towards solving the problem was to show that the following two equations had no solution as had been predicted by Fermat:

$$x^3 + y^3 = z^3 \text{ and } x^4 + y^4 = z^4$$

But, then, there were an infinite number of such equations and mathematicians were supposed to examine them all to find if any of them had a solution.

Sophie did not follow the usual approach to solve the problem; that is, whether a particular equation had a solution or not. She developed a new line of attack. Rather than proving that there were no solutions for a given value of n, she showed that if there were a solution, a certain condition would have to apply. She wanted to find out whether a particular set of equations had solutions or not. She focussed her attention on a particular set of equations in which n is equal to a particular type of prime number – a prime number which when multiplied by 2, and 1 was added to the result, led to another prime number. Such prime numbers are called 'Germain primes'. 3, 5 and 11 are examples of such prime numbers because 7 (2 x 3 + 1 = 7), 11 (2 x 5 + 1 = 11), and 23 (2 x 11 + 1 = 23) are prime numbers. 13 is a prime number but it does not qualify to be a Germain prime because 27 (2 x 13 + 1 = 27) is not a prime number. Some more examples of Germain primes are: 23, 29, 41, 53, 83, 89, 113, and 131. Germain showed that those equations of the family of equations $x^n + y^n = z^n$ had probably no solutions where n is a Germain prime. To have a solution of such an equation either x, y, or z must be a multiple of n. Such a condition put a tight restriction for any equation to have a solution. This way Germain excluded a whole set of equations and left the remaining ones for the mathematicians to prove one by one in an attempt to solve the Fermat's last theorem. This insight would later lead to the proof for Fermat's Last Theorem where n = 5.

Sophie Germain died on 27 June 1831 after fighting with breast cancer for two years. After her death she has been honoured by her country in several ways. One of the streets of Paris, Rue Sophie Germain, was named after her. The Sophie Germain Hotel is located at 12 Rue Sophie Germain. The house located at Rue de Savoie in which she died has been declared as a historical landmark. A school, L'Ecole Sophie Germain, was named after her.

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

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The Beautiful Game

popularization is evidenced from the commercial sponsorship received for the science programmes beamed on Doordarshan jointly by Vigyan Prasar and ISRO.

What holds true for Football also holds true for other sports – *and also Science and Technology*. At the individual level, the first and foremost is the will – will to excel in whatever we do, come what may. Next, we must learn to work as a team; and ask ourselves what we can do for our country rather than what the country can do for us. At the State level, we need to popularize science just the way we need to popularize football and other sports, and attract greater participation and inculcate interest in science. There has to be a conscious and concerted effort on a continuing basis to spot the talent and to nurture it – both financially and academically. For this purpose, the lead will have to be taken by our premier scientific and professional institutions and the leading scientists. Indeed, it is heartening to note that scientists at the Indian Institute of Science, Bangalore, have already taken an initiative to convey to the youth the thrill and challenges a scientific career can offer. Once we are successful in this endeavor, we shall have the best of talent opting for science as a career. Then we shall be able to produce our own home-grown Ronaldos and Ronaldinhos of Science.

To popularize science, we shall need to learn new techniques, adopt new skills and also experiment. To score a goal, one needs to cut through the opposition and resistance of the rival team – working together in a coherent manner. For this purpose, one may need to pass the ball to a teammate, dribble, or head the ball into the net. One may even need to learn the special skills of Ronaldinho's "elastico" where he stretches the opponent one way and races the other way towards the goal, or Zidane's "roulette" where he uses a high-speed 360 degree turn to dribble the ball past an opponent. One may even learn to "bend" the ball like Beckham wherein by spinning it he produces a curved trajectory. Only then a goal becomes possible. This is what makes football a beautiful game. And this is what makes science a beautiful game.

❑ **Vinay B. Kamble**

Towards Nutrition Security

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The Tenth Plan has noted that though severe malnutrition has decreased, and consequently severe nutritional deficiency has almost disappeared, the level of malnutrition among children is still quite high, as manifested through moderate and severe underweight. According to the Planning Commission's document, over 66% of children below the age of 6 are moderately under-nourished and the problem is more severe in rural areas. If severe nutritional deficiency has almost disappeared the contribution of the National Institute of Nutrition located at Hyderabad to achieve this is not insignificant. Its research work and field studies on various facets of the nutritional status of the population have led to effective intervention programmes. NIN has now geared up its potential to deal with the prevailing malnutrition among children/vulnerable groups and health disorders arising from deficiencies, which has come to be known as "hidden hunger".

Fig. 1 : The National Institute of Nutrition in Hyderabad

NIN has its origin in the Beri Beri Enquiry Unit set up at the Pasteur Institute in Coonoor, Tamil Nadu way back in 1918. Subsequently, as the scope of its work expanded, it was renamed as Deficiency Diseases Enquiry Unit and later as Nutrition Research Laboratories. In 1958 it was shifted to Hyderabad and in 1969 it was re-christened as the National Institute of Nutrition (NIN). Subsequently, three other organizations were set up on NIN campus, namely the Food and Drug Toxicology Research Centre (FDTRC), the National Nutrition Monitoring Bureau (NNMB) and the National Centre for Laboratory Animal Sciences (NCLAS).

Over the years, they have broad-based their research work to cover a wide range of issues affecting the community at large. The community studies and regular monitoring of the nutrition status of population at different levels carried out by these organizations have helped in the formulation of effective intervention programmes. The community studies covered fluorosis in northwestern districts of Tamil Nadu, nutritional status in Saharia Tribes of Rajasthan and haemoglobin status from RCH study.

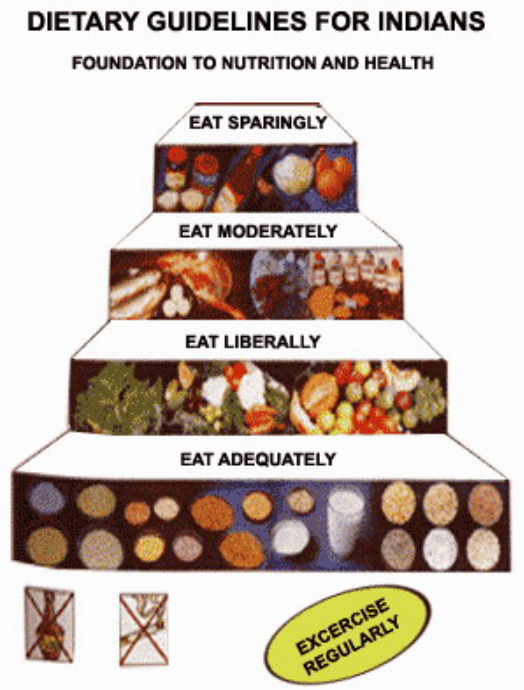

Fig. 2 : Dietary guidelines for Indians (Source: NIN)

The nutritional assessment survey, carried out among Saharia tribes in Shahbad and Kishanganj blocks of Baran district of Rajasthan, revealed that the average intake of various foods, except for cereals and millets was less than the recommended levels, while that of protective foods like pulses, green leafy vegetables and milk and milk products was grossly inadequate. The prevalence of clinical forms of vitamin A deficiency among pre-school children was observed to be much higher than that reported for the State as a whole. The overall prevalence of under-weight among the Saharia tribes was 72%, while that of severe grade was 24 per cent. The overall prevalence of stunting was 68% and that of wasting was 13 percent. The prevalence of chronic energy deficiency (CED) among adults was higher (56%) as compared to that reported for the State (45%). The study highlighted the need for strengthening of health and nutrition programmes such as RCH, ICDS and MDM in this tribal community.

Another survey carried out in nine drought-hit States during May-June 2003 had brought out the low levels of

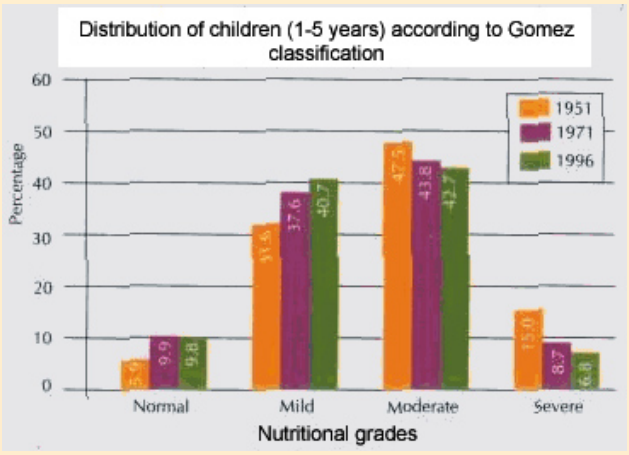

Fig. 3 : Nutritional grades of children in India (Source: NNMB)

mean intake of foodstuffs in almost all the States implying that food security among the households was not at all encouraging. The prevalence of underweight among pre-school children was found to be more than 50%, while the prevalence of chronic energy deficiency ranged between 26% and 49% among males and between 30% and 51% among females. Yet another large-scale study covering eight states carried out by the NNMB brought out the extent of micro-nutrient deficiencies. It was found that the overall prevalence of vitamin A deficiency among pre-school children was around 0.8% ranging from nil in Kerala to a maximum of 1.2% to 1.4% in Andhra Pradesh, Maharashtra and Madhya Pradesh. The prevalence was above the WHO criterion of 0.5% in all States except Kerala and Orissa. The overall prevalence of goitre among children in the age group 6-12 years was about 4%, which was less than the WHO criterion of 5 per cent. However the prevalence in two States, Maharashtra with 11.9%, and West Bengal with 9%, was much higher than the WHO criterion. Around 58% of the households surveyed used iodized salt but in not all the households using iodized salt the iodine levels were satisfactory. The overall prevalence of anaemia was found to be 78% among lactating women, 75% among pregnant women, 70% among adolescent girls and 67% among pre-school children. The prevalence of anaemia in West Bengal and Orissa was more than 90 per cent. The survey brought out that the coverage of target groups for distribution of massive dose of vitamin A and iron and folic acid tablets was very low. It was also noted that the awareness of micronutrient deficiency disorders was not satisfactory. These findings have helped policy makers to take mid-course corrections in the national nutrition programmes and initiate action for effectively tackling the problem of "hidden hunger".

The study to assess the haemoglobin status of women and children was carried out in the first phase in 2002-2003, which showed that about 88.4% of subjects were seen suffering from anaemia. In the second phase of the study carried out in 2004-2005, about 95% of samples showed anaemia. Women and children of Uttar Pradesh and Dadra and Nagar Haveli were seen to be worst affected, whereas those in Kerala and Goa were comparatively better.

Clinical Studies

Besides community studies, NIN has been conducting a number of clinical studies. One of these revealed that Indian women from low-income groups have high levels of body fat at comparatively lower body mass index (BMI) levels than other ethnic groups. Even women in the adequate BMI category (18.5 - 23) had unacceptable high levels of body fat. The increase in weight and BMI was associated with increase in body fat percentage, whereas the increase in height was associated with increase in lean mass but not fat percentage.

Dried Blood Spot Technology

Assessment of vitamin A status in the population is a prerequisite to successful prevention and control of vitamin A deficiency disorders. Serum vitamin A (retinol) concentration is the most commonly used biochemical indicator for assessing vitamin A status of the people. Currently, high performance liquid chromatography (HPLC) is used for this purpose, but this requires relatively large volume of venous blood and involves its transport and storage at laboratory for analysis, which in turn requires complex instrumentation. The scientists at NIN have therefore introduced a technology, which eliminates the cumbersome process of handling, preservation and transport of the specimen. This is based on the Dried Blood Spot (DBS) method for collecting blood samples on a special type of filter paper using finger prick and later analyzing them in the laboratory for vitamin A status.

A national facility for promoting this DBS technology for vitamin A estimation has been set up at NIN in 2004 with financial support from the Micronutrient Initiative (MI), New Delhi and equipment grant from the Ministry of Science and Technology (MoST). It is a procedure for obtaining samples from remote areas on a special filter paper and analysis of the vitamin A content in the sample.

Besides vitamin A deficiency disorders, iodine deficiency disorders (IDD) and iron deficiency anaemia (IDA) continue to be public health problems. Already, iodized salt is being promoted amidst strong opposition from certain sections of the public on the ground that it would make an essential commodity like salt costly and beyond the reach of the poorer sections of the community. However, the decline in the prevalence of goitre in recent years has vindicated the stand taken by the policy makers in favour of promoting iodized salt. NIN has developed a technology to fortify iodised salt with iron, which can bring down the prevalence of anemia as well.

Now, sugar can also be considered for fortification to eliminate micronutrient deficiencies, as is being done in some parts of the world. Scientists at NIN have developed a technology to fortify sugar with iron, iodine

and both. Preliminary studies have reportedly shown that the fortified sugars are accepted well in foods. Iodized sugar has been accepted well in coffee and tea, but the iron fortified and the double fortified (i.e., iron and iodine) sugar has not been accepted in tea. In coffee they are accepted only when the iron level is up to 200 ppm. Anyhow, the NIN scientists are trying to improve the technology before it is offered for actual implementation.

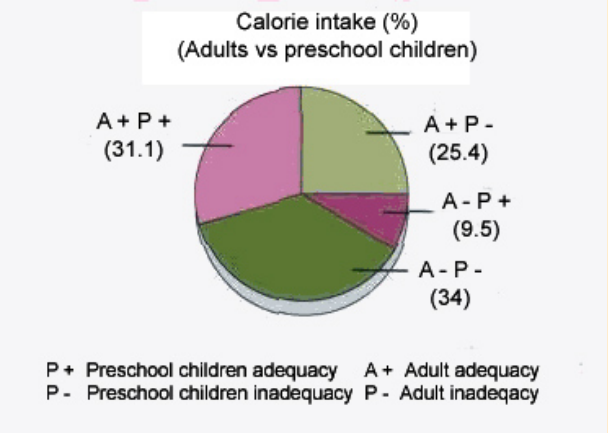

Fig. 4 : Calorie intake status of adults and preschool children. (Source: NNMB)

Wheat atta fortified with micronutrients by NIN scientists is being distributed successfully through the Public Distribution System (PDS) in two districts of Andhra Pradesh on an experimental basis. NIN is all set to help other state governments too.

Fortification of Supplementary Food

The NIN has also prepared a draft Country Investment Plan for micronutrient fortification of food supplement of ICDS and Mid-Day Meals in Orissa and Rajasthan. This project was undertaken on the recommendation of an expert group, comprising representatives from the Department of Women and Child Development (DWCD), the Ministry of Food Processing Industries, Director of NIN and ICMR, set up to examine a similar plan prepared by the NIN for Andhra Pradesh and Orissa on an assignment from the Keystone Center, USA on behalf of Asian Development Bank. The plan, estimated to involve an investment of Rs 43.8 crore over a three-year period, envisages fortification of the supplementary food under ICDS and School Noon Meal Programmes. The micronutrients, identified for such fortification, include iron, iodine, zinc, vitamin A, thiamin, riboflavin, folic acid, and ascorbic acid. The Plan seeks to cover children in the age group 6 months to 14 years, adolescent girls, pregnant women and lactating mothers. The NIN would monitor the projects and carry out baseline diet and nutrition survey.

Nutrition Surveillance

Yet another area in which the NIN has made a significant contribution relates to the development of a Nutrition Surveillance System (NSS) as envisaged in the National Nutrition Policy to provide early warning signals about the impending nutritional problems and correct them at all levels. The system developed by NIN was tested in Andhra Pradesh using the ICDS infrastructure and based on the "Triple A" – assessment, analysis and action-approach. A national workshop organized to review the NSS developed by NIN recommended its expansion to other states in the country in a phased manner. Following the successful results of the Pilot Project in Andhra Pradesh this system has now been extended to Maharashtra, Rajasthan, Karnataka, Madhya Pradesh and Meghalaya. The main advantage of this system is that the entire population, especially the vulnerable sections, would be under surveillance and the groups at risk could be identified well in time to initiate corrective steps. It envisages growth monitoring at quarterly intervals, which in turn would enable early diagnosis of children with growth faltering. It would help mapping of the extent of undernourishment at the grassroots. This can lead to a paradigm shift in the ICDS programme during the Tenth Plan.

Generation of greater awareness about nutritional problems plays an important role fuelling 'nutrition security' among the vulnerable groups. Realizing this the FAO and a group of organizations had launched a global nutrition education initiative, named "Feeding Minds, Fighting Hunger" (FMFH), for school children. NIN carried out a study between October 2002 and 2004 to evaluate the efficacy of FMFH lesson plans in improving nutrition-related knowledge levels of the schoolchildren in Hyderabad. Nutrition education given through teachers using FMFH lesson plans and other communication material such as posters, skit and classroom activities in the classroom setup resulted in a significant improvement in the knowledge levels of pupils in experimental group. The study brought out the efficacy of FMFH programme in improving nutrition-related knowledge of schoolchildren.

Admittedly the formulation and effective implementation of nutrition policies and programmes depends upon the availability of sound scientific data on the current nutritional status of different sections of the population. Over the last three decades the National Nutrition Monitoring Bureau (NNMB) of the NIN has been providing this data for nine (eleven of late) States every year and based on this, the intervention programmes are designed. However, one of the constraints that NNMB faces is that it has to operate on a shoestring budget provided on a year-to-year basis as it exists in a project mode since its inception. Nutrition experts feel that if NNMB is expanded and given a permanent status as an integral part of NIN it would help obtain data on a continuous basis for all the States and this in turn would help identify the gaps in the implementation of various nutrition-related programmes at the grassroots and achieving the goal of nutrition security.

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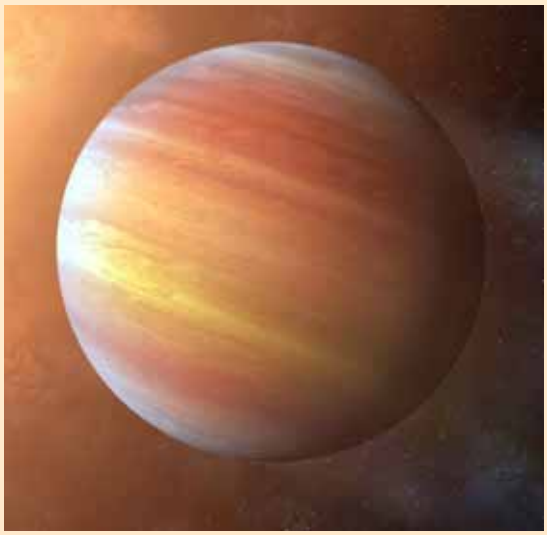
How Many Planets in the Sky?

Part II – Extra-solar planets

❑ Prof. K.D. Abhyankar

Soon after Copernicus introduced the heliocentric hypothesis of planetary motions the Italian philosopher Giordano Bruno (1548-1600) argued that there might be planets around other stars in the sky. This idea was not liked by the Christian Church, because it would require separate prophets for people living there thus denying the uniqueness of the Christian Prophet. So Bruno was burnt at the stake. But now it is generally accepted that there are indeed planets around other stars and some of them may even have intelligent life. So astronomers have started searching extra-solar planets in order to understand the origin of the solar system and the origin of life on Earth.



This artist's concept shows 51 Pegasi B, or Bellerophon as the gas giant has been dubbed, which was the first extrasolar planet to be discovered around a sunlike star. This planet is so close to its' star that the temperature is about 1,300 degrees Kelvin.

Masses of stars range from about 100 times the mass of the Sun to one-tenth the mass of the Sun. Of these, stars heavier than the Sun rotate very rapidly with equatorial speeds of more than 100 km per second. The Sun itself has an equatorial speed of only 2 km per second. It is believed that the low-mass stars have slowed down by transferring their angular momentum to a surrounding nebula where planets get formed. There are 10 billion stars in the Milky Way galaxy and most of them are low-mass stars. So we may have billions of planetary systems in the Milky Way. The Hubble Space Telescope has photographed several stars surrounded by gaseous disks that shine in infrared light emitted by the dust in the disk. So one expects that planetary systems would be discovered if searched for.

Detection of Extra-solar Planets

There are several methods available for detecting extra-solar planets. Taking the Sun-Jupiter system as a typical model we can think of the following observations.

(i) When observed from outside the solar system, Jupiter would transit over Sun's disk once in 12 years, causing a reduction of the latter's brightness by one per cent for 6 days. It is difficult to detect such small changes of brightness occurring at long intervals. Similar observations are possible for distant stars with planetary systems. However, in the case of a central transit and the bending of the starlight around the planet due to the general relativistic effect, there also occurs considerable increase in the star's brightness due to the phenomenon of gravitational lensing. Of course this requires the Earth to lie exactly in the plane of the planet's orbit around the distant parent star. A few such transits have been observed in the past couple of years.

(ii) Jupiter moves around the centre of mass of the Sun-Jupiter system at a distance of 5.2 AU. At the same time the Sun also moves around the centre of mass at a much smaller distance of 0.052 AU. This will produce a wavy motion of the Sun (parent star) if the orbit of the planet is perpendicular to the line of sight. The corresponding angular displacement of the star as seen from the star Alpha Centauri at 4.2 light years will be like looking at one-rupee coin from a distance of 4 million kilometres. The planet itself will show a displacement 1,000 times larger, but it is still quite small. Such observations can be made from space telescopes only. Further, in order to see the planet the light of the star will have to be cut off with special techniques. Several missions of this type are being planned by NASA and ESO.

(iii) The most successful method of detecting extra-solar planets so far has been that of measuring the periodic variation of the radial velocity of the star due to its motion around the centre of mass of the star-planet system. (Radial velocity, in astronomy, is the speed with which a star moves toward or away from the Sun. It is determined from the red or blue shift in the star's spectrum.) Here also the alignment of the orbit with the line of sight is helpful. In the case of the Sun-Jupiter system the velocity of the Sun amounts to 13 metres per second; for the Sun-Earth system it will be much smaller, about 9 cm per second. At present the accuracy of measuring radial velocity is such that one can detect planets of mass of Jupiter or Saturn

in a distant planetary system. Efforts are on to increase the accuracy of measurement of radial velocity by using very large telescopes so that it will be possible to detect planets of Earth's mass.

Present Inventory of Extra-solar Planets

The first extra-solar planet was discovered in 1995. The star 51 Pegasi was found to have a planet of mass equal to 0.46 times the mass of Jupiter (M_J) that orbits the star at a distance of 0.05 AU with a period of 5 days. In the next two years the number of extra-solar planets increased to 7 as shown in Table 1. Three of them form a planetary system around the star μ Andromedae.

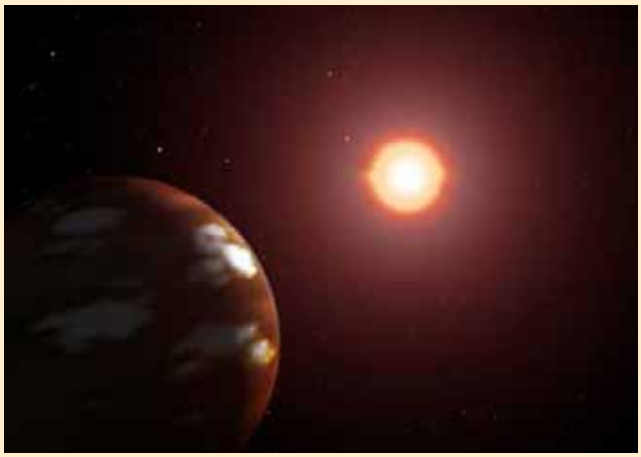
Table 1: Early Extra-solar Planets

Year	Star	Planet mass	Period	Semi-major axis (AU)
1995	51 Pegasi	0.46 M_J	5 d	0.05
1996	55 Centauri	0.8 M_J	40 d	0.2
	70 Virginis	6.5 M_J	116 d	0.5
	47 Ursa Majoris	3 M_J	1,100 d	2.0
1997	μ Andromedae		4 d	0.04
			242 d	0.8
			3.5 yrs	3.0

By 2000 the number of extra-solar planets detected totalled 40. One of the stars, HD 46325, was found to have a planet of mass 0.8 times the mass of Saturn (M_S) or 0.24 M_J, with a period of 3.02 d and semi-major axis of 0.03 AU. At present there are more than 194 extra-solar planets in the list. Statistically their number increases with decreasing mass and increasing semi-major axis. So we expect many Earth-size planets in future. The shapes of the orbits of the planets range from circular (e = 0) to highly eccentric (e = 0.7).

Nature of Jupiter-size Extra-solar Planets

All the stars in Table 1 are similar to Sun in mass, radius and surface temperature of about 6,000 Kelvin. But their Jupiter-size planets are much closer to the parent stars than Jupiter's distance from the Sun (5.2 AU). In the solar system the inner planets from Mercury to Mars are rocky, because they were formed in the region of the solar nebula that was closer to the Sun and hot enough to evaporate all gases. On the other hand the giant planets from Jupiter to Neptune were formed in the outer cold region and they could accumulate the abundant gases like hydrogen and helium around their rocky cores. It is therefore reasonable to assume that the Jupiter-size extra-solar planets were also formed at large distances and later came closer to the parent star. The question arises whether they could still retain gases.



This artist's concept shows the Neptune-sized extrasolar planet — about 10 to 20 times the size of Earth — circling the star Gliese 436. In this depiction, the planet, which was discovered in 2004, appears gaseous like Jupiter, with a cloudy atmosphere. Image coutesy: NASA.

Let us consider the planet of 51 Pegasi. It is 100 times closer to the parent planet when compared to Jupiter's distance from the Sun. So it receives 10,000 times more energy, which it radiates back into space. According to Stefan-Boltzman law the radiated energy is proportional to the 4th power of temperature; so the surface temperature of the said planet would be 10 times that of Jupiter. As Jupiter has a surface temperature of 125 K, that of 51 Pegasi's planet would be 1,250 K. In spite of this high temperature the planet is able to retain its accumulated gas because its large mass requires a large escape velocity. Its gaseous atmosphere is expected to have clouds of iron compounds in the lowest layer, clouds of magnesium silicate ($MgSiO_3$) in the middle layer and gases CO, CH_4, NH_3 and H_2O in the upper layer. If one could obtain its spectrum in future it should show bands of CO and H_2O molecules.

In order to know the radius of an extra-solar planet one needs to observe its transit across the disk of the parent star. Such a transit was observed in the case of the star HD 209488. It gave for the planet a mass of 0.68 M_J and a radius of 1.35 times the radius of Jupiter (R_J). But according to the theory of the Indian physicist D.S. Kothari the radius of a planet should be proportional to the cube root of its mass. In the present case the planet's radius should be 0.88 R_J, but it is much larger. This indicates that the planet has not yet fully contracted and cooled to its normal size.

While concluding this discussion of extra-solar planets it is to be noted that this topic is intimately connected with the question of extraterrestrial life. (In this respect the reader may refer to Chapter 11: 'Life in the Universe' in the author's book *Astrophysics of the Solar System* published by the Universities Press, Hyderabad.)

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Simple Exercises for Your Back

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A daily preventive drill can swell your chances of a sturdier, healthier back. By stepping into a routine, you could well be buying an insurance policy to a pain-free youthful back. Try to work 15-20 minutes of exercise into your daily routine, and strengthen the muscles of your lower back and abdomen – they support and protect your spine. If you're out of condition, start slowly and increase gradually. If you're over 40 or have an illness or injury, check with your doctor before you get started.

You should also keep a few other things in mind. At first, begin gently and go slow. Do not try to do too much at once. Over a period of days, you will steadily improve your range of movement. Carry out every exercise a maximum of five times. Never stretch yourself so hard that you feel pain. Take a break of at least five counts before beginning the next exercise. During each movement, slowly breathe in, over five seconds, and while returning to the position of rest, breath out slowly taking the same time.

Doing the following exercises shall hold your back in good stead:

Trunk strengthening exercises

Begin with some basic trunk strengthening exercises.

Knee to shoulder stretch

Lie on your back with your knees bent and feet flat. Pull your left knee toward your chest with both hands. Hold for 15 to 30 seconds. Return to starting position. Repeat with opposite leg. Repeat with each leg three or four times.

Lifting the hips

Lie on your back with your knees bent and feet flat. Raise the hips gently till you do not suffer any pain. Hold for a count of five. Repeat five times.

Head and chest raise

Lie with your face down, and hands folded over your back. Raise the head and the chest a few centimetres. Hold for a count of five. Repeat five times.

Leg lifts

Step 1 : Lie face down on a firm surface. Keeping your knee bent, raise your leg slightly off the surface and hold for a count of five. Repeat five times.

Step 2. With your leg straight, repeat the exercise. Raise one leg slightly off the surface and hold for a count of five. Repeat five times.

Some more exercises

If you can make time, consider also doing the following exercises that are useful for the muscles of your back:

Chair stretch

Sit in a chair. Slowly bend forward toward the floor until you feel a mild stretch in your back. Hold for 15 to 30 seconds. Repeat three or four times.

Cat stretch

Get down on your hands and knees. Slowly let your back and abdomen sag toward the floor. Slowly arch your back away from the floor. Repeat several times.

Shoulder blade squeeze

Sit upright in a chair. Keep your chin tucked in and your shoulders down. Pull your shoulder blades together

and straighten your upper back. Hold a few seconds. Return to starting position. Repeat several times.

Neck exercises

Devote a few minutes daily for doing neck exercises. This will strengthen your neck muscles and also preserve the flexibility of your neck joints. Take the first lessons with a physiotherapist, and then make it a routine.

Simple neck movements

Step 1: Sit upright, preferably with a back support. Tilt your neck backward, hold for five counts, and return to the neutral position. Relax.

Step 2: Now, *turn* your neck to the left, hold, and return to the neutral position. Now repeat the same manoeuvre taking the neck to the right. Each time your chin should approach your shoulder. Relax.

Step 3: *Tilt* the neck left and then right and try and get the ear to approach the shoulder.

Shoulder rotation

Flex both your elbows (up straight) so that your fingers touch the shoulders. Now churn your shoulders in a slow motion making a big arc, first in the forward direction and then backward. Repeat 15 times. Gradually increase the range of the arc as your mobility improves.

Tightening the neck muscles

Step 1: Sit upright. Using your left palm, apply pressure on your left cheek but do not let your neck move. Resist any movement of the neck by tensing your neck muscles. Hold this position for five counts. Ease the pressure, and relax. Repeat the same manoeuvre using the right palm against the right cheek.

Step 2: Using your left palm, apply pressure on your left temple but do not let your head move. Resist the movement by tensing your neck muscles. Hold this position for five counts. Ease the pressure, and relax. Repeat the same manoeuvre using the right palm against the right temple.

Step 3: Place both your hand behind your head and clasp them across. Now, press the back of the head from behind, but do not let your head move. You'll feel your neck muscles to tighten. Hold this position for five counts. Ease the pressure, and relax. Repeat the same manoeuvre using your clasped hands against the forehead.

Abdominal strengthening exercises

Abdominal muscles help support and protect the back. It would therefore be useful to include the following exercises in your routine – they will help to strengthen your abdominal muscles.

Hollow and round your back

Lie on your back with your knees slightly bent and your feet resting on the floor. Now try to hollow and round your back and set it mid-way. Hold for a count of five. Your abdominal stabilizer muscles should be well contracted. Repeat five times.

Half sit-up

Lie on your back on a firm surface with your knees bent and feet flat. With your arms outstretched, reach toward your knees with your hands until your shoulder blades no longer touch the ground. Do not grasp your knees. Hold for a few seconds and slowly return to the starting position. Repeat several times.

Stretch out the hamstrings

The hamstrings run at the back of the thigh all the way down till your knee. If they are too tight, you could stress your lower back. If you sit for long in a low chair, like in a car, you could be courting trouble. The best preventive recipe is to stretch your hamstrings. Doing this is simple.

Lie down on your back facing up. Hold your thigh with one hand and the calf with the other, and bring your knee close to your stomach. Now, gradually, perhaps over a period of days or weeks, try to straighten the

knee so that the thigh is stretched 90-degree (perpendicular) to the back. Repeat five times.

Walking is a good option

Many people do not think of walking as a workout, but it is perhaps the best all-round exercise for anyone. A brisk 30- to 45-minute walk most days of the week exercises the whole body, perks up your overall fitness and strength, improves muscle tone and helps you shed excess pounds, all of which may protect your back.

Walking briskly and swinging your arms will help you get the full benefit from your exercise. Remember to walk tall with your shoulders back and your head up. After a while, you will find you can walk faster and further. Set yourself sensible goals and increase the distance gradually.

Begin slowly and build up. In the first week, do 15-20 minutes a day. Then increase progressively by 10 minutes each week to make it a 30-45 minute daily routine by the end of the fourth week.

WALK PLAN	
Day 1-7	15-20 min
Day 8-14	25-30 min
Day 15-21	35-40 min
Day 22	45 min

If you are in a fit condition, walk at a rate so that your heart rate increases to between 60 and 80 per cent of its calculated 'maximum'. Calculating the maximum heart rate (MHR) is easy. Just subtract your age from 220. If you are 45, it will be 220-45 =175. The next step is to calculate the 60 and 80 per cent of this: 175 multiplied by (60/100) = 105 and 175 multiplied by (80/100) = 140. Hence, if you're 45, your goal should be to walk at a pace which pushes and maintains your heart rate between 105 and 140 beats per minute. Count your pulse only after you have settled down into a good rhythm. The best advantages of walking fructify only when you walk within this range.

TARGET HEART RATE			
Age	Max. Heart Rate	60% Level	80% Level
25	195	117	156
30	190	114	152
35	185	111	148
40	180	108	144
45	175	105	140
50	170	102	136
55	165	99	132
60	160	96	128
65	155	93	124

Simple stretch-outs to perk you up

Sitting at work for eight hours a day can cause office workers syndrome—fatigue, stress, and back pain. Three 5-minute stretch breaks a day will perk you up, relax your muscles and enhance your flexibility. This may even help improve your job performance.

Here are five exercises you can do without leaving your desk. Hold each stretch for 10 to 20 seconds. Repeat each exercise once or twice on both sides.

- Slowly tilt your head to the left until you feel a stretch on the side of your neck. Repeat to the right and forward.
- Hold your left arm just above the elbow with your right hand. Gently pull your elbow across your chest toward the right shoulder while turning your head to look over the left shoulder.
- Raise your left elbow above your head and put your left palm on the back of your neck. Now grasp your left elbow with your right hand. Gently pull your elbow behind your head and toward your right shoulder until you feel a nice stretch in your shoulder or upper arms.
- Hold your left leg just below the knee. Gently pull your bent leg toward your chest. Hold it with your right arm and pull it toward your right shoulder.
- Cross your left leg over your right leg. Cross your right elbow over your left thigh. Gently press your leg with your elbow to twist your hip and lower and middle parts of your back. Look over your left shoulder to complete the stretch.

• • •

Earthquake Tip 2

How the Ground Shakes?

Seismic Waves

Earthquakes are the result of the release of large strain energy, which travels as seismic waves in all directions through the Earth's layers, reflecting and refracting at each interface. These waves are of two types - *body waves* and *surface waves*; the latter are restricted to near the Earth's surface (Figure 1). Body waves consist of *Primary Waves (P-waves)* and *Secondary Waves (S-waves)*, and surface waves consist of *Love waves* and *Rayleigh waves*. Under P-waves, material particles undergo alternate compression and extensional and decompression along direction of energy transmission, but under S-waves, the particles oscillate at right angles to it (Figure 2). Love waves cause surface motions similar to those caused by S-waves, but with no vertical component. Rayleigh waves make material particles oscillate in an elliptic path in the vertical plane (with horizontal motion along direction of energy transmission).

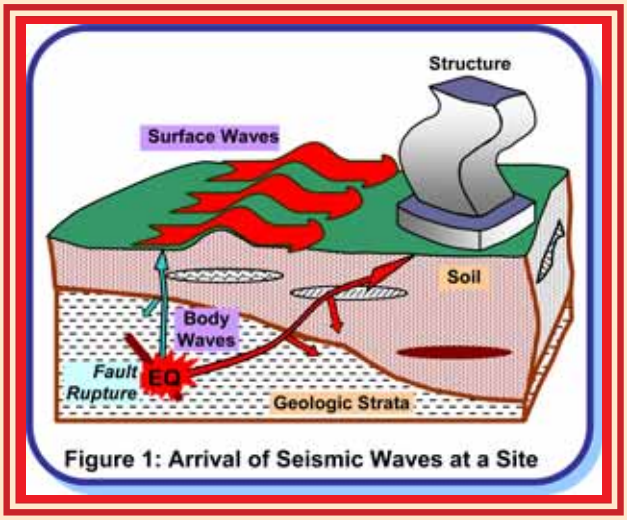

Figure 1: Arrival of Seismic Waves at a Site

P-waves are the fastest, followed in sequence by S-waves, Love and Rayleigh waves. For example, in granites, P- and S-waves have speeds of about 4.8 km/s and around 3.0km/s, respectively. S-waves do not travel through liquids. In association with effects of Love waves they cause maximum damage to structures by their racking motion on the surface in both vertical and horizontal directions. When P- and S-waves reach the Earth's surface, most of their energy is reflected back. Some of this energy is returned back to the surface by reflections at different layers of soil and rock. Shaking is more severe (about twice as much) at the Earth's surface than at substantial depths. This is often the basis for designing structures buried underground for smaller levels of acceleration than those above the ground.

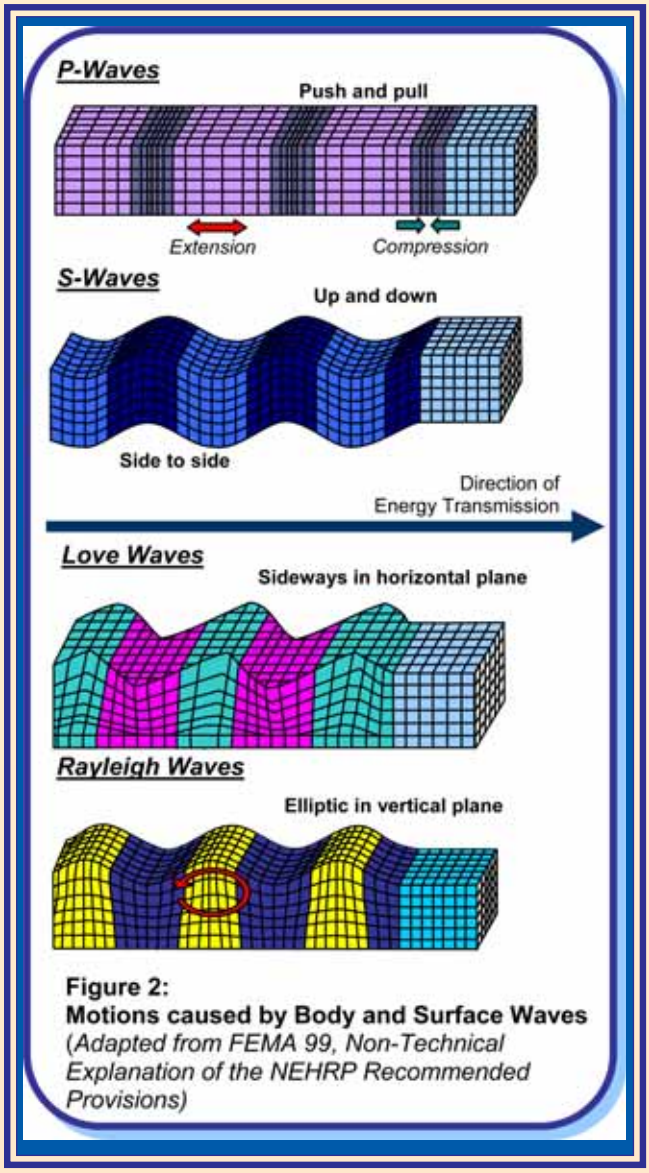

Figure 2:
Motions caused by Body and Surface Waves
(Adapted from FEMA 99, Non-Technical Explanation of the NEHRP Recommended Provisions)

Measuring Instruments

The seismograph is an instrument that measures earthquake shaking. It has three components – the *sensor*, the *recorder* and the *timer*. The principle on which it works is simple (Figure 3) – a pen attached at the tip of an oscillating simple pendulum (a mass hung by a string from a support) marks on a chart paper that is held on a drum rotating at a constant speed. A magnet around the string provides required damping to control the amplitude of oscillations. The pendulum mass, string, magnet and support together constitute the *sensor*; the

drum, pen and chart paper constitute the *recorder*; and the motor that rotates the drum at constant speed forms the *timer*.

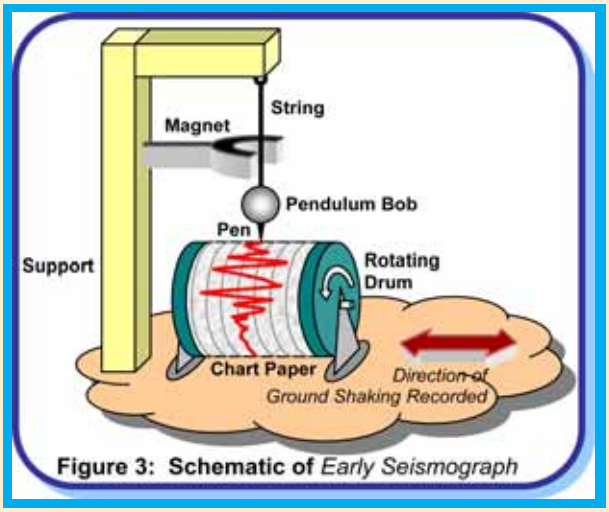

Figure 3: Schematic of *Early Seismograph*

One such instrument is required in each of the two orthogonal horizontal directions. Of course, for measuring vertical oscillations, the *string* pendulum (Figure 3) is replaced with a *spring* pendulum oscillating about a fulcrum. Some instruments do not have a timer device (*i.e.,* the drum holding the chart paper does not rotate). Such instruments provide only the maximum extent (or scope) of motion during the earthquake; for this reason they are called *seismoscopes*.

The analog instruments have evolved over time, but today, *digital instruments* using modern computer technology are more commonly used. The digital instrument records the ground motion on the memory of the microprocessor that is in-built in the instrument.

Strong Ground Motions

Shaking of ground on the Earth's surface is a net consequence of motions caused by seismic waves. These waves arrive at various instants of time, have different amplitudes, and carry different levels of energy. Thus, the motion at any site on ground is random in nature with its amplitude and direction varying randomly with time.

Large earthquakes at great distances can produce weak motions that may not damage structures or even be felt by humans. But, sensitive instruments can record these. This makes it possible to locate distant earthquakes. However, from engineering viewpoint, strong motions that can possibly damage structures are of interest. This can happen with earthquakes in the vicinity or even with large earthquakes at medium to large distances.

Characteristics of Strong Ground Motions

The motion of the ground can be described in terms of displacement, velocity or acceleration. The variation of ground acceleration with time recorded at a point on ground during an earthquake is called an *accelerogram*. The nature of accelerograms may vary (Figure 4) depending on the energy released at source, type of slip at fault rupture, geology along the travel path from fault rupture to the Earth's surface, and local soil (Figure 1). They carry distinct information regarding ground shaking, such as peak amplitude, duration of strong shaking, frequency content (*e.g.,* amplitude of shaking associated with each frequency), and energy content (*i.e.,* energy carried by ground shaking at each frequency) that are often used to distinguish them.

Peak amplitude (*peak ground acceleration, PGA*) is physically intuitive. For instance, a horizontal PGA value of *0.6g* (= *0.6* times the acceleration due to gravity) suggests that the movement of the ground can cause a maximum horizontal force on a rigid structure equal to *60%* of its weight. In a rigid structure, all points in it move with the ground by the same amount, and hence experience the same maximum acceleration of PGA. Usually, strong ground motions carry significant energy associated with shaking of frequencies in the range *0.03-30Hz (i.e., cycles per sec)*.

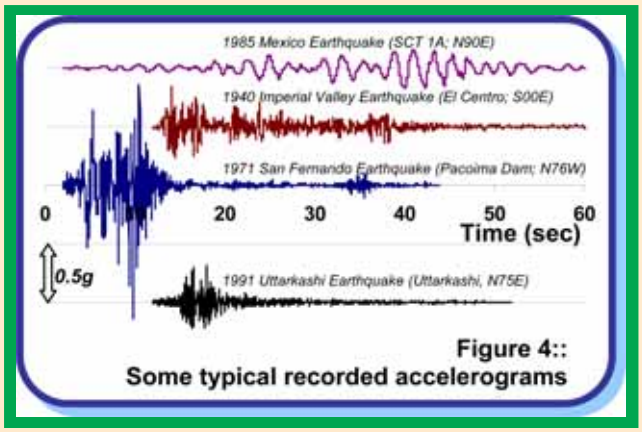

Figure 4:: Some typical recorded accelerograms

Generally, the maximum amplitudes of horizontal motions in the two orthogonal directions are about the same. However, the maximum amplitude in the vertical direction is usually less than that in the horizontal direction. In design codes, the vertical design acceleration is taken as *1/2* to *2/3* of the horizontal design acceleration. In contrast, the maximum horizontal and vertical ground accelerations *in the vicinity* of the fault rupture do not seem to have such a correlation.

Resource Material

1. Bolt,B.A., (1999), *Earthquakes*, Fourth Edition, W. H. Freeman and Company, New York, USA.

Acknowledgement :

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Sponsored by : Building Materials and Technology, Promotion Council, New Delhi, India

Recent Developments in Science and Technology

New nanomaterial fuses silk and silica

Researchers have created a new nanomaterial, which may help in the fabrication of replacement bones. This new material has strength like spider silk and rigidity like silica. David Kaplan of Tufts University, Medford, Massachusetts, USA along with his Tufts graduate students and collaborators Carol C. Perry and Siddharth V. Patwardhan from Nottingham Trent University in UK, and Rajesh Naik from the Air Force Research Laboratory, Ohio, USA, combined protein that constitutes the drag lines of golden silk orb weaver spider with the protein that helps diatoms (single-celled marine organisms) make silica, a glass-like substance. Silica provides structural support to diatoms while silk proteins from spiders and silkworms are more flexible and stronger. The Tufts researchers were able to design and clone genetic fusions of the encoding genes for the two proteins, and then generate these genetically engineered proteins into nanocomposites at room temperatures using only water.

The researchers are testing this material *in vitro,* but in near future tests will be carried out on animals to find out if the material can guide the growth of hip replacement, for example. One advantage of the new material is that it can be produced at ambient temperature without the use of chemicals or high temperatures. At present, high temperatures and harsh conditions are typically required for industrial synthesis of silica in the laboratory. This new research has been published in proceeding of the National Academy of Science.

Source: www.sciam.com

Plasma needle could replace the dentist drill

Eva Stoffels-Adamowicz, physicist and her colleagues at the Eindhoven University of Technology, Netherlands have come up with a 'plasma needle', which could revolutionise dentistry. The plasma needle is cold and painless to touch and could one day replace the dentist's drill used in conventional dentistry. Stoffels-Adamowicz came up with the idea for the needle while working with low-pressure plasma, which are created in a vacuum. In order for the plasma to be used on people, the team developed a plasma needle that works in air. The needle is a 50-millimeter-long tungsten wire enclosed in a quartz tube filled with gas; driving a voltage through the needle generated a small plasma spark at its tip.

The researchers have used the needle to generate nitric oxide plasma by flushing helium gas and air into the tube. The helium helps the plasma to form efficiently from air at low energies. The team found that when the nitric oxide plasma is produced using small amounts of energy and applied in short bursts, it can kill bacteria while leaving other living cells unharmed, which could make the treatment of dental caries almost painless. Stoffels-Adamowicz's team is now working on a method to generate plasma that can be sent down blood vessels through a catheter. They are hopeful that plasma therapy may one day be used to clear blocked arteries and could also be used to painlessly remove cancerous tissue.

Source: www.newscientist.com

Three new cataract causing genes identified

Scientists at Centre for Genetic Disorders of Guru Nanak Dev University in Amritsar, in association with researchers from National Institutes of Health, USA and Institute of Human Genetics in Berlin, Germany, have identified three genes believed to cause cataracts. Congenital cataract affects three out of every 10,000 newborns and is a significant cause of blindness in children and lifelong visual disability for many. The researchers collected DNA samples of more than 2,400 individuals with congenital cataract of the eye.

The first breakthrough came in year 2001 when two genes were identified that could be linked to the disease. A third was subsequently identified. The two genes discovered in 2001 have already been assigned unique international identification numbers. The researchers hope that the third gene will get a new identification number soon. Knowledge of the genes may open up new strategies to tackle the problem in future.

Source: PTI news

Endowing adult cells with embryonic powers

Stem cells are unspecialised human or animal cells that can produce mature specialized body cells and at the same time replicate themselves. Embryonic stem cells are derived from a blastocyst, which is very young embryo that contains 200 to 250 cells and is shaped like a hollow sphere. The stem cells themselves are the cells in the blastocyst that ultimately would develop into a person or animal. This property of stem cells has attracted researchers looking for a better way of repairing damaged organs. But it was believed that only embryonic stem cells had the capacity to grow into different kinds of tissue that could be used for organ repair; adult stem cells did not. Reprogramming adult human cells to repair damaged tissue or organs was considered to be almost impossible, and the use of embryonic stem cells was considered unethical. But now a team of researchers at Kyoto University, Japan have developed a chemical cocktail that makes adult mouse cells behave like embryonic stem cells, and the recipe is surprisingly simple.

Through a process of elimination, Shinya Yamanaka and his colleagues at Kyoto University narrowed down the candidates to a group of just four genes that, when introduced together into the tail-tip cells, could produce colonies of embryonic stem-like cells of mice. Three of the four factors – Oct4, Sox2, and c-Myc – are all key genes in both early embryos and embryonic stem cells. Yamanaka did not name the fourth gene, but he said it is a transcription factor that until now has not been recognized as playing a major role in embryonic stem cells. The researchers are confident that the same technique could be used to turn adult human cells into embryonic stem-like cells. This could avoid the ethical issues that the use human embryonic stem cells raise.

Source: Nature, 6 July 2006.

Complied by : Kapil Tripathi

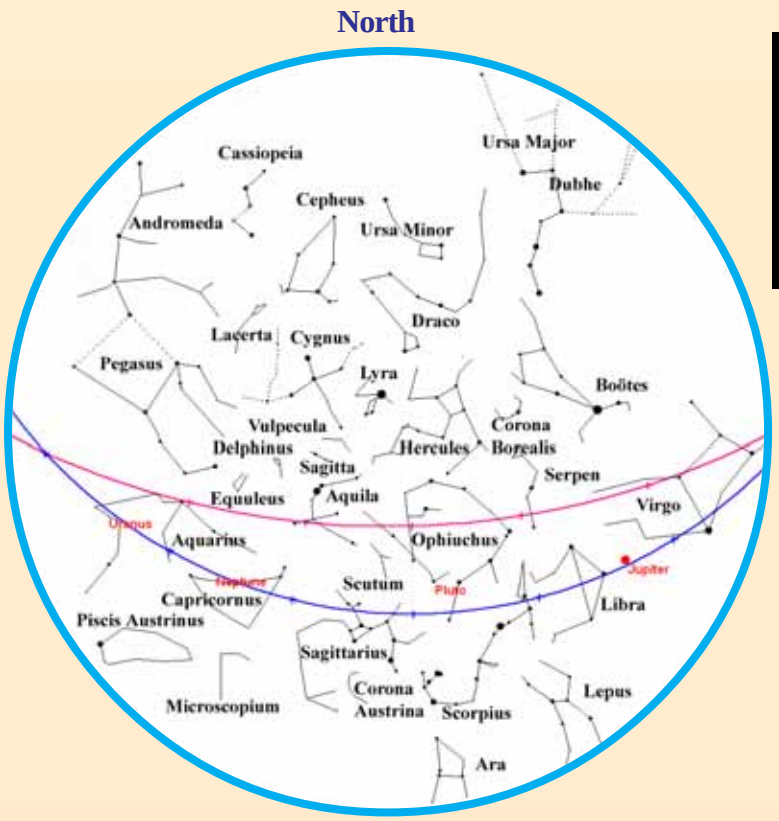
Sky Map for August 2006

Moon - First Quarter

1 & 30 August

Full Moon

9 August



Moon - Last Quarter

17 August

New Moon

23 August

The sky map is prepared for viewers in Nagpur (21.09^0 N, 79.09^0 E). It includes bright constellations and planets. For viewers south of Nagpur, constellations of the southern sky will appear higher up in the sky, and those of the northern sky will appear nearer the northern horizon. Simillarly, for viewers north of Nagpur, constellations of northern sky will apper higher up in the sky, and those of the southern sky will appear nearer the southern horizon. The map can be used at 10 PM on 1 August, at 9 PM on 15 August and at 8 PM on 31 August.

Tips for watching the night sky:

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

Planet Round Up :

Jupiter: In the constellation *Libra (Tula Rashi)* at Western sky.
Uranus, Neptune and Pluto: Not a naked eye objects. Hence not visible.

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

Eastern Sky	:	Pegasus/*Mahashva,* Andromeda/*Devayani,* Aquarius/*Kumbha Rashi,* Piscis Austrinus, Capricorns/*Makar Rashi*.
Western Sky	:	Virgo (Spica)/*Kanya (Chirra),* Libra/ *Tula Rashi,* Bootes (Arctrus)/ *Bhutaap (Swati)*
Southern Sky	:	Ara, Corona Austrina, Scorpius (Antares)/*Vrischik Rashi (Jeshta),* Sagittarius/*Dhanu Rashi,* Microscopium.
Northern Sky	:	Ursa Major/*Saptarshi,* Ursa Minor (Polaris), Cassiopeia/*Dhanishta,* Cepheus/*Vrishaparv,* Draco/*Kaleea.*
Zenith	:	Aquila (Altair)/*Garuda (Sravan),* Cygnus (Deneb)/*Hansa (Hansa),* Lyra (Vega)/*Swaramandal (Abhijeet),* Hercules/*Shauri,* Ophiuchus/*Bhujangdhari,* Corona Borealis/*Uttar Mukut.*

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VP News (Contd. form page...40)

State Level Ham Radio Training...

Dehra Dun (Shri B.P. Semwal, VU3BPZ, Shri Rajendra Pal, VU3RPC, Shri C.K. Dixit, VU2CKD, and Shri K. Ram, Scientist, Defence Electronics Applications Laboratory (DRDO) also offered their helping hand during the training programme. Dr. Prashant Singh (NSS Coordinator, Dehra Dun) coordinated the event. The valedictory function of the training programme was held on June 26, which was chaired by Dr. Ashok Sen, Director, DEAL, Dehradun. Dr. Subodh Mahanti, Scientist 'F', represented Vigyan Prasar at the valedictory function. International Monitoring Station, New Delhi, conducted the Amateur Station Operator's Certificate Examination on June 28 and 29, 2006 at Rajiv Gandhi Navodaya Vidyalaya, Dehra Dun.

It was decided that U-COST would set up ham radio club stations across the different districts of Uttaranchal to facilitate emergency communication during any natural calamities. Initially, a ham radio club station would be established at Rajiv Gandhi Navodaya Vidyalaya, Dehradun.

Workshop on Innovative...

remarked that these type of workshop would definitely enhance the teaching skills and knowledge of the teachers.

In the two-day workshop numbers of activities were conducted for the teachers. A group discussion on the topic "Changes in the ways of physics teaching" was also conducted on the second day of the workshop. The session was chaired by Dr. C.M. Nautiyal, Scientist, Birbal Sahani Institute of Paleobotany. Mrs. Indu Mathur, Principal, Army Public School, and Shri R.D Shukla Physics teacher of Army Public School were present in the discussion. Participants interacted with the experts during the session.

A poster exhibition on 'General Theory of Relativity', 'Special Theory of Relativity' 'The life and works of Einstein' was put up in the auditorium, which were highly appreciated by the participants. The films on 'Discovery of Radio-activity', 'The Magical year of Einstein,' and life and works of Prof. A.K. Raychoudhary were screened. A resource material kit containing CDs, publications of Vigyan Prasar and Astronomy kit was distributed among the participants.