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Vigyan Prasar

# DREAM 2047

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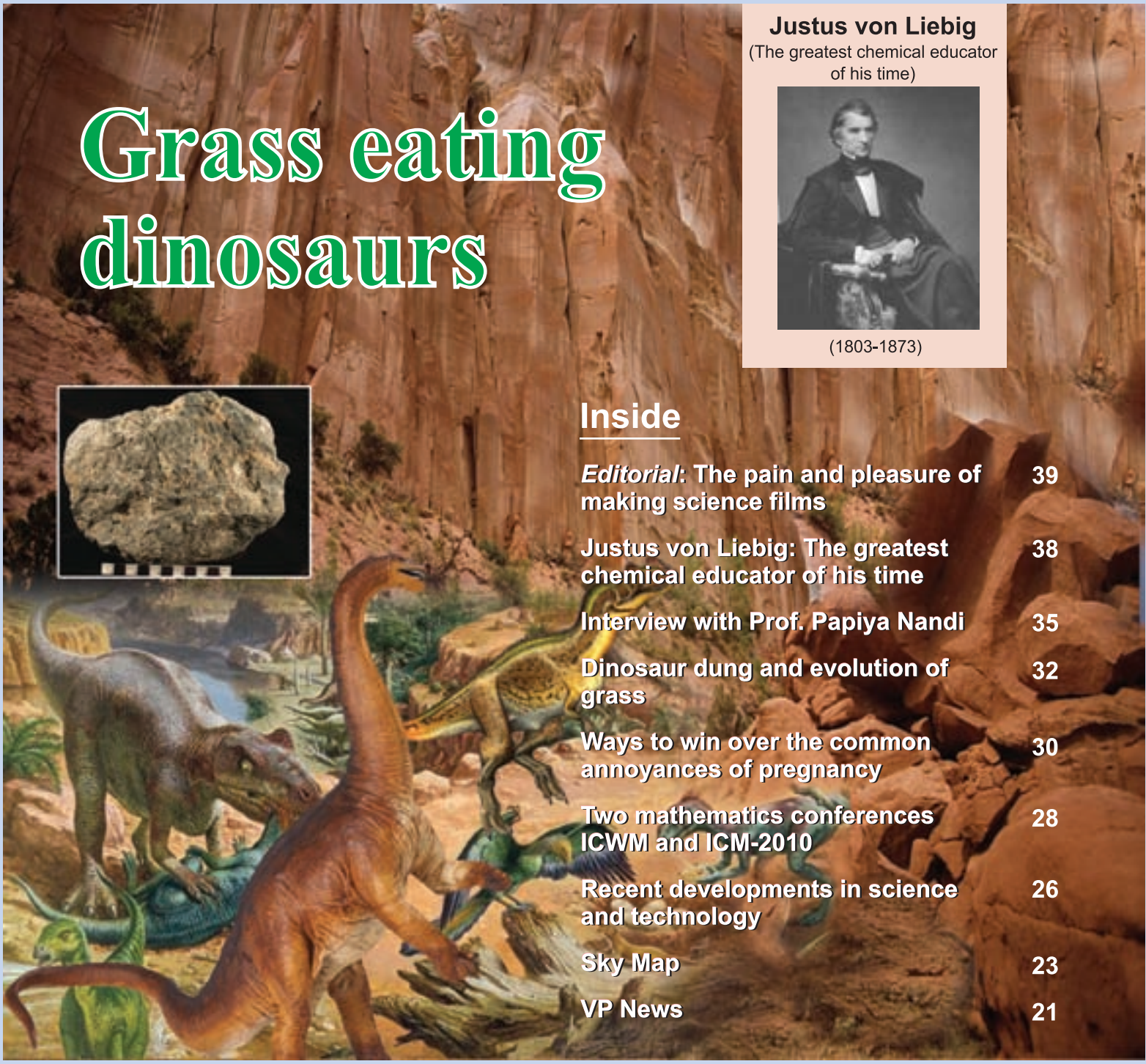

## Grass eating dinosaurs

**Justus von Liebig**
(The greatest chemical educator of his time)

(1803-1873)

## Inside



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

# The pain and pleasure of making science films

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How can you faithfully communicate your ideas and thoughts? By writing these down, which was the classical method; or by making a film, which has emerged as a contemporary method. Over the past century we have witnessed how this audiovisual medium has evolved with significant technical breakthroughs on the one hand and how the art of telling a story in an engaging way has emerged on the other. Films on science subjects, both feature and documentary, have benefitted immensely from these developments.

The producer is an important entity who besides raising material resources selects his team. He should be able to express his vision with adequate clarity and after that allow space for creativity. Monitoring should not result in interference and only production decisions should be referred to him.

The director needs to spend considerable time on pre-production research and in understanding the script. The work should be accepted only when there is clarity of action on all significant issues. The understanding arrived at at this stage will ensure that the final product meets the requirement of the producer. Selecting the teams both technical/production and for acting is a critical step.

Readers are aware that making programmes for television and for screening in cinema halls calls for different approaches and the creative teams have to design the format accordingly. The grammar and composition are unique to both media and the quality of the message(s) in the final product reflects poorly if liberties have been taken.

Using professional actors, if demanded by the script, is a challenge for a director who has to achieve a high level of appreciation of the skills and emotional characteristics of these sensitive artists. Most directors prefer to use a limited set of actors with whom they have built a relationship of mutual trust. Skilled technicians are, similarly, rare, always in demand and therefore very busy.

From the design and preparation of the sets, to completing the editing – each vital step calls for creative planning, coordination, and control. The director stakes his career with every assignment since he is valued by his latest offering.

Commencing with search for a good story the challenge includes writing an interesting script, shooting the film, and displaying rough cuts. Each stage can witness a return to the drawing board or revisiting some segments by the producer. With many government departments as also in Vigyan Prasar a committee of experts (mostly external) has to recommend the acceptance. With sponsorship and phased release of funds linked to clearing each stage, the director has to defend each shot and angle.

The above is not to scare prospective film makers. The art and craft of science film making can be very satisfying. Creative inputs at every stage, reinforced with positive feedback of the producer, help the director go the extra mile. Where alternative and back up tactics have been worked out there is little deviation in schedule and therefore the budget remains in control. Major upsets can occur if schedule begins to slip, which result in adverse pressure from the sponsors.

Distribution of science films is another aspect that needs addressing. Most of these are with institutions that use it for building a reference library and screening at opportune times. There are some efforts at repackaging TV films with updation, if necessary, for a second screening on the same or some other channel.

The investment in science films depends on graphics and animations that are increasingly needed to make the story interesting and understandable. The success of natural history films depends crucially on capturing rare and difficult events and this needs multiple camera teams stationed at difficult sites. Raising finances for such projects is not easy although critical acclaim may be bestowed.

Non-fiction science films are often hybrids in their approach and finish. Social representation with some honorable exceptions is a key differential from entertainment or commercial films. Programmes for television, on the other hand, are often formatted as game shows and incorporate elements of competition. Serials are often made and telecast because of several factors that are not always based on viewership demand.

A number of young people are interested in science film making and this is a healthy trend. The lack of patronage notwithstanding, many short films are being made in media schools and by newly established companies. This needs to be acknowledged and encouraged. Vigyan Prasar has created a platform in the Annual Session of the Indian Science Congress for showcasing such talent and this can, optimistically, provide a major step up for science films and film makers.

**Anuj Sinha**

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**Editor: Er Anuj Sinha**

# Justus von Liebig

## The greatest chemical educator of his time

**Subodh Mahanti**
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"Liebig was remarkable for the wide range of his work. There were greater chemists in the 19th century but none who worked with such authority over such an enormous field."

*A Dictionary of Scientists*, Oxford University Press, 1999.

"I would...establish the conviction that Chemistry, as an independent science, offers one of the most powerful means towards the attainment of a higher mental cultivation; that the study of Chemistry is profitable not only inasmuch as it promotes the material interests of mankind, but also because it furnishes us insight into those wonders of creation which immediately surround us, and with which our existence, life and development are most closely connected."

Justus von Liebig (*Familiar Letters on Chemistry*, 1843)

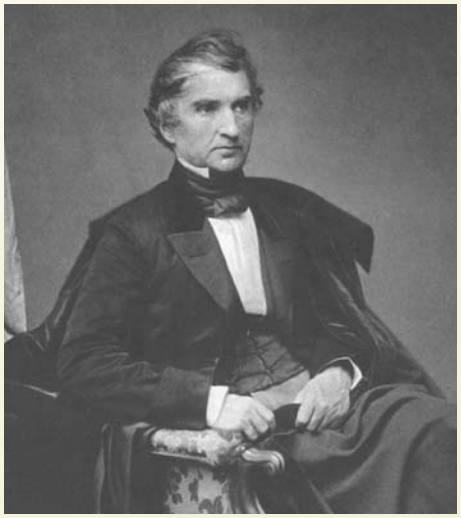
Justus von Liebig's reputation as a chemist was so great that he was regarded as the final authority in chemical matters. In the 18th century chemistry was the monopoly of France. However, Liebig changed the scenario and the 19th century chemistry became the monopoly of Germany.

Liebig greatly helped to systematise organic chemistry, biochemistry, agricultural chemistry and chemical education. He developed a quick and accurate method for analysing organic compounds. Using this method Liebig and his students analysed hundreds of organic compounds. Their results were the basis for the great advances to be made in organic chemistry after about 1850. It was Liebig who first demonstrated the existence of free radicals. He also helped to understand the properties of acids in greater details.

Liebig changed the very nature of scientific agriculture. His views moved agriculture towards chemistry. In fact, he is regarded as the founder of the discipline agricultural chemistry. He is also regarded as the father of fertiliser industry.

Liebig argued against any hard and fast distinction between living (physiologically produced) and dead chemical (laboratory produced) processes. He said: "...the production of all organic substances no longer belongs just to the organism. It must be viewed as not only probable but as certain that we shall produce them in our laboratories. Sugar, salicin (a white crystalline glucoside), and morphine will be artificially produced." Liebig's idea proved to be great inspiration to others. Liebig argued that carbohydrates and fats are the fuel of the animal body.

Liebig was the greatest chemical educator of his time. He developed the modern laboratory-oriented teaching method. His laboratory at the Giessen University was the first modern laboratory where students could be trained in chemical analysis and to become independent research investigators.



*Justus von Liebig*

The Liebig condenser is a device for vapour condensation. Such a device existed long before Liebig began his research, but it was named so because he popularised it among chemists. He invented the process of silvering (1835). This invention made possible to substantially improve the utility of mirrors.

Justus von Liebig was born on 12 May 1803 in Darmstadt, Germany. His father was a dealer in drugs, dyes, and associated chemicals and he experimented in his private laboratory to improve his products. Davy's early interests in chemistry was due to the fact that he was allowed to play with the chemicals in his father's private laboratory. Liebig was apprenticed to an apothecary named Gottfried Pirsch (1792-1870) in Heppenheim.

He attended the University of Bonn, where he studied under Karl Wilhelm Gottlob Kastner. Incidentally Kastner was also his father's business partner. When Kastner moved to the University of Erlangen, Liebig also accompanied him. Liebig received his PhD degree from Erlangen.

In 1822, Liebig went to Paris. This was possible by a grant from Hessian Government, which he received because of Kastner's recommendation. In Paris he submitted a paper based on his investigations on silver and mercury fulminates, earlier carried out at Erlangen, to the Academie des Sciences. Liebig's paper attracted the attention of Alexander von Humboldt (1769-1859) who arranged for Liebig to work with Joseph Gay-Lussac, who had a private laboratory of his own. Liebig's work on fulminates also led to the discovery of the phenomenon of isomerism. But then it was possible because of Wohler's work on silver cyanate. It was found that the composition of silver cyanate worked out by Wohler was same to that of Liebig's silver fulminate. The works of Liebig and Wohler demonstrated that two chemical compounds with entirely different properties could have the same elementary composition. This was a case of isomerism and it happens because the elements in the two compounds are arranged in different manner. The term "isomerism" was proposed by Berzelius. It was derived from Greek word "*isomeros*" meaning "composed of equal parts." While in Paris, Liebig also came in contact with Georges Cuiver (1769-1832).

*The young Liebig—1843 lithograph after an 1821 drawing*

In 1824, Liebig was appointed extraordinary professor in the Philosophical Faculty at the University of Giessen. At the time of his appointment he was just 21 years old. It is said that while appointing Liebig, the Grand Duke bypassed the election process of the faculty. After a year Liebig succeeded to the Chair of Chemistry. It is believed that Alexander von Humboldt played an important role in Liebig's appointment. Liebig remained at Giessen until 1852 before he moved to the University of Munich.

It was Liebig's laboratory at Geissen that the teaching and research of modern chemistry began in a systematic way. Liebig's laboratory could be considered as the first modern laboratory of chemistry. The laboratory was established to train new pharmacists. Liebig demonstrated how organic analysis could be successfully taught and how students could be trained to undertake chemical research independently. In fact, it was Liebig who established the independent and scientific status of chemists. Liebig's method of training scientists was adopted as a model in Germany and other parts of the world.

Liebig's association with publishing began when a Heidelberg pharmacist named Phillip Lorenz Geiger (1785-1836) made him co-editor of *Magazin fur Pharmacie*. Geiger wanted Liebig to verify the papers submitted for publication for their factual correctness. The name of the journal changed to *Annalen der Pharmacie* in 1832. After Geiger's death Liebig renamed the journal as *Annalen der Chemie und Pharmacie*. After Liebig's death, the journal was renamed, first as *Justus Liebig's Annalen der Chimie und Pharmacie* and then *Justus Liebig's Annalen der Chemie*. The journal's name again changed to Liebig's Annalen der Chemie and then *Liebig's Annalen* in 1995. The journal lost its independent existence in December 1997, when it was absorbed into the *European Journal of Organic Chemistry*.

In 1840, Liebig published his *Chemistry in its Applications to Agriculture and Physiology*. From the response it evoked it was obvious that it was one of the most important books in scientific agriculture. It was translated into many languages and ran through several editions. The book was a comprehensive compilation of findings of earlier investigators on the subject. Liebig also used his own findings to decide between alternative theories. Through this book Liebig wanted to attract the attention of botanists and physiologists to the importance of chemistry in their subjects. Before Liebig the only serious attempt to apply chemistry to agriculture was made by Humphrey Davy (1778-1829). Davy's *Elements of Agricultural Chemistry in a Course of Lectures for the Board of Agriculture* (which was based on his series of lectures given at the Royal Institution in London in 1813) was the only standard work before Liebig's publication. Liebig believed that green plants supported all life and the plants themselves sustained on inorganic elements found in air and in the soil. According to him green plants received carbon from carbon dioxide in the air and nitrogen from ammonia. He also believed that ammonia was a component of rainwater. But he was proved to be wrong and later he advocated the use of some ammoniacal salts in plant fertilisation.

Based on his detailed analysis, Liebig demonstrated the presence of chemical elements like potassium, calcium, sodium and phosphorus in plants. He believed that these elements must come from the soil itself. However, mineral content of soils cannot remain same forever. After years


*German postage stamp on Liebig (1953)*

*Joseph Gay-Lussac*

of cultivation the mineral contents of a particular piece of land can get diminished to an extent that it no longer can support agriculture. But then it was also known that if no crops were grown on a particular piece of land it replenishes itself with minerals and becomes productive again. The process of natural replenishment is rather slow. Liebig suggested that the process of replenishment could be augmented by use of mineral fertilisers containing potash and phosphates. However, Liebig believed that mineral fertilisers should be added to the soil in insoluble state otherwise they would be washed away by rainwater. Liebig was proved wrong. Plants needed these mineral in soluble state and the soil is capable of holding these minerals irrespective of rainfall. Liebig might not have achieved desired success with chemical fertilisers but he showed the way for other researchers. It can definitely be said that modern fertiliser industry is result of Liebig's ideas.

In 1842, Liebig published his much discussed publication, *Animal Chemistry or Organic Chemistry* in *Its Application to Physiology* and *Pathology*.The book became highly popular. Soon after its publication the book was translated into English, French and Dutch and attracted both admiration and criticism. Otto Kohlrausch (1811-1854), a Hannover physician, commenting on the book wrote: "Liebig shows us a path which if properly followed can lead to the most fundamental method of observation in the entire field of medicine." This statement could be considered as the most constructive criticism. Many thought that Liebig's ideas were not based on available experimental

*Alexander von Humboldt*

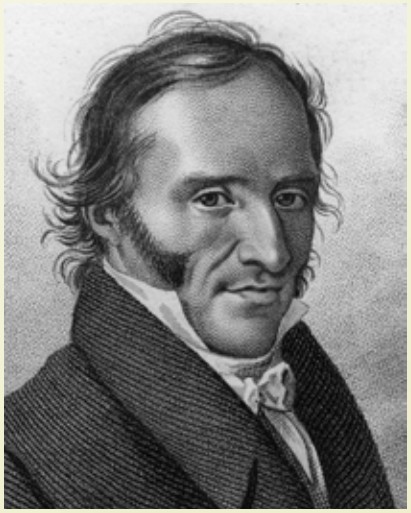
evidence; rather they were mere wishful thinking and highly speculative. Berzelius wrote: "The easy kind of physiological chemistry is created at the writing desk, and is the more dangerous, the more genius goes into its execution, because most readers will not be able to distinguish what is true from mere possibilities and probabilities, and will be misled into accepting as truths probabilities that will require great effort to eradicate after they have become imbedded in physiological chemistry. To the extent that it is easy in this manner to do physiological chemistry, which has many chemical facts with great possibility of combination, it is likely that the aspiration to the first to bring this probability-physiology to market will produce conflict over priority, to the detrimental of science." Incidentally Liebig dedicated the book to Berzelius, but apparently it had no effect on the latter. Liebig's *Animal Chemistry* highlighted the importance of incorporating chemistry into physiology and clinical medicine. His ideas were responsible for pushing empirical medicine to the new scientific medicine.

Liebig was not in agreement with Berzelius on how fermentation takes place. Berzelius believed that fermentation was caused by a catalytic force and the yeast was nothing but a non-living catalyst. Liebig himself came forward with a mechanistic explanation for fermentation. While explaining the process of fermentation, Liebig entered into long dispute with Louis Pasteur. Contrary to Pasteur's observation, Liebig considered fermentation simply as a chemical reaction independent of living organisms. Liebig thought fermentation took place because of the transmission of vibration from the violently moving particles in the mixture. He refused to belief that yeast was a living organism. That yeast is a living organism was proved in 1836 by Charles Cagniard de Latour (1777-1859) and was independently confirmed by Theodor Ambrose Hubert Schwan (1810-1882) and Friedrich Traugott Kutzling (1807-1893). At the end it was Pasteur who proved to be right. He demonstrated beyond any doubt that fermentation was caused by living organism such as yeast cells. It is interesting to note that in 1839, Liebig and Friedrich Wohler published a satirical caricature role of the yeast in fermentation. They visualised yeast as animal eggs that hatch at tremendous speed into innumerable small animals that consumed sugar and excreted alcohol and carbonic acid.

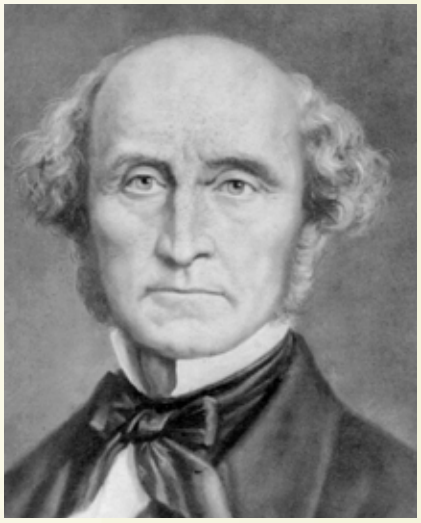
Liebig's promotion of science-based agriculture and his role in the publication of John Stuart Mill's *Logic in Germany* influenced the process of reforming politics in the German states. Liebig liked Mill's Logic because it highlighted the importance of science as a means to social and political progress. It may be noted that Mill quoted several examples of Liebig's research to prove his point.

Liebig, jointly with George Giebert, a Belgian engineer, perfected an efficient method of producing beef extract from carcasses. The extract was a cheap, nutritious alternative to real meat. To market their product they established the Liebig Extract of Meat Company in 1865. Later in 1899 the product was trademarked "Oxo".

Liebig was elected a member of the Royal Swedish Academy of Sciences in 1837.



*Georges Cuiver*



*John Stuart Mill*

He was made a Baron (Freiherr) in 1845. He died on 18 April 1873 in Munich, Bavaria. He was buried in the Alter Sudfriedhof in Munich.

The University of Giessen, Liebig's alma mater, was renamed after him, Justus-Liebig-Universitat Giessen. Liebig's laboratory at Giessen University, which survived the destruction of Giessen in the Second Wold War, has been converted into a museum. In 1953, a postal stamp was issued in his honour by the West German postal department to mark his 150th birth anniversary.

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(The article is a popular presentation of the important points of the life and work of Justus von Liebig available in the existing literature. The idea is to inspire the younger generation to know more about Justus von Liebig. The author has given the sources consulted for writing this 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.)

# We spot talent and nurture tomorrow's scientists

Jagadis Bose National Science Talent Search (JBNSTS), Kolkata is an Autonomous Registered Society promoted by the Government of West Bengal and administered by a Governing Body with representatives from the State Government, Academics and Industry. Conceptualised in 1958 by visionaries such as Dr. B C Roy and Sir Jehangir Ghandy, JBNSTS was initiated to commemorate the Birth Centenary Celebration of India's first modern scientist, Acharya J C Bose. The programme was inaugurated by Pandit Jawaharlal Nehru.

Prof. Papiya Nandy, Honorary. Director of JBNSTS, is a scholar from the first batch of this institute. Her objective is to make JBNSTS a vibrant and dynamic institute to motivate, identify and nurture young talented science students and establish the base for scientific enquiry and culture of tomorrow.

Prof. Papiya Nandy received her Master's degrees from Calcutta University and University of California, Santa Barbara. Her Ph.D. work on liquid crystal was conducted at the Liquid Crystal Institute of Kent State University, USA under Prof. Wilbur M. Franklin and Prof. Alfred Saupe. She switched to the field of experimental biophysics when she joined the group of Prof. Erich Sackmann at the Max Planck Institute fur Biophysikalische Chemie at Gottingen, Germany, which was continued later at University of Ulm, Germany.

After returning to India she was at Bose Institute for a brief period as Pool Officer, CSIR and then joined the Physics Department of Jadavpur University. There, besides teaching in the science and engineering faculties, she is in charge of several research projects and has established herself as a recognised expert in membrane biophysics.

Er Anuj Sinha, Director, Vigyan Prasar and Consultant, Department of Science & Technology, Govt. of India interacted with Prof. Nandy on the country's educational scenario especially in science and technology education and role of Jagadis Bose National Science Talent Search (JBNSTS), Kolkata in motivating and nurturing students towards science education. Here are excerpts of the interaction.

*Dream 2047:* The educational scenario is evolving rapidly. There are far reaching

*Prof. Papiya Nandi, Director, JBNSTS*

developments at the national and regional levels. You have been at the helm of the Jagdish Bose National Science Talent Scheme (JBNSTS) for several years. What have been the recent developments in JBNSTS?

PN: Established in 1958 as a modest talent search institute in West Bengal, JBNSTS has come a long way and now has a presence on the national scene. Some recent developments are – increase in the number of scholarships from 10 to 32, increase in the amount of annual scholarship from Rs 6,000 to Rs 12,000 and moving to a new premises in October 2005.

*Dream 2047:* What are the facilities at this centre?

PN: We have a fully air conditioned 120-seat auditorium, a 60-bed dormitory (15 beds separately for girls), and two rooms for visiting faculty members. There are laboratories, library and space for creative work. We have a solar powered ope- air activity terrace and a water harvesting structure in the backyard. There are facilities of a kitchen, dining space and of course office space for the centre.

*Dream 2047:* Bright students find mathematics daunting. While there have been developments in teaching/ learning high school maths, what efforts has JBNSTS made in reinforcing concepts and principles of math teaching/ learning?

PN: No, this is covered as part of our regular programmes. I find that the scholars are generally very good in both science and maths. Often we take the participants to BITM Mathematics Gallery to create renewed interest in this discipline.

*Dream 2047:* The effort to support scholars from the northeastern states was a pioneering step. There has been lack of sponsorship for this recently. How do you propose to extend your reach in NE states and what are the strategies to further improve it?

PN: Since 1991, JBNSTS had been conducting talent spotting in the northeastern states. The programmes were designed to motivate students to pursue a career in science through thematic workshops and identify talented students through multiphase Junior Talent Search Tests. The programme was initially sponsored by Ministry of Human Resource Development and then for the last year by Ministry of North Eastern Region, Govt. of India. Due to some changes in the policy of these Ministries, these programmes had to be abandoned.

However, the Department of Science and Technology provides some project grant to conduct one/ two sensitisation workshops every year in these states. I am optimistic that the value of the work done by JBNSTS over the last two decades will

*Students' activity in a science camp at JBNSTS*

be realised and either our institute or some other competent body will be requested to encourage the talented students of this region.

*Dream 2047:* Developments in the fields of mass communication and the digital revolution warrant an improvement in the new generation of scholars. Have there been significant changes in quality of scholars/ students and any trends that you have observed in their levels of creativity?

PN: This is a complex question and I would like to answer this in parts.

(a) The knowledge base of the scholars/ students has improved, but there is no significant rise in the level of creativity. There could be reasons that need to be explored and addressed;

(b) more students are inclined to pursue a career in basic sciences. This displays a trend that can yield interesting insights to policy makers; and

(c) more students are opting for job/research opportunities in India itself, reflecting development of a healthy ambience for research in our universities and laboratories.

*Dream 2047:* Can you describe some important lessons from JBNSTS for INSPIRE (Innovation in Science Pursuit for Inspired Research) which is a young programme although in terms of scale will be very much larger?

PN: We commenced our activities over five decades back and have internalised many lessons over the years. Many of our scholars have stayed in touch and they give valuable inputs periodically. Some components of INSPIRE will address the same group of scholars that JBNSTS has been reaching albeit at a national level. I suggest that:

(a) INSPIRE should provide more opportunity for interaction among its scholars and the Institute that guides and nurtures them. The stories of success by young scholars are very inspiring and kids relate to these more than with achievements of very senior scientists.

(b) INSPIRE should play the role of a mentor for its scholars and should not reduce itself to a scholarship disbursing machinery. JBNSTS has retained its links with scholars from every batch and they form a great foundation for our activities.

*Henry Ortiz of Los Angeles conducting a science camp at JBNSTS*

(c) INSPIRE should conduct evaluation of its activities and impact on a regular basis. There will be academic criticism and independent evaluation but DST should set in place its own mechanism to give early feedback and take corrective action.

*Dream 2047:* What are your views on INSPIRE and its impact on JBNSTS? Please analyze both positive and negative aspects.

PN: INSPIRE is a well-thought out initiative launched recently. It addresses the concerns of the scientific community by spotting talent very early and providing encouragement till a scholar establishes himself or herself. JBNSTS has remained exclusive for the region and today is a recognised and coveted scholarship. Having said this I feel that the effect of INSPIRE on JBNSTS is positive in terms of awareness created about JBNSTS in all the announcements and the role that we can have for the region. As INSPIRE-JBNSTS scholars cannot be brought under the same umbrella as JBNSTS, there is little scope for follow up. I also suspect that the fraternity feeling among the INSPIRE-JBNSTS scholars could not be built up.

*Dream 2047:* Dr Nandy you have spent several years in Jadavpur University and the past deacde as Honorary Director JBNSTS. Do you have any regrets or a sense of satisfaction on the professional front?

PN: I and incidentally even Dr Nandy (we married later) were part of the first batch of scholars. Teaching and guiding scholars has become our life.

The accomplishments of my students give me a lot of satisfaction irrespective of their current affiliations in India or abroad. I have consciously attempted to network my scholars with each other. Even as research grants in current times remain competitive, I think more emphasis should be given for encouraging team spirit. Modern research requires working with wide range of experts and this requires fundamental social skills.

*Dream 2047:* In view of your vast experience in teaching and research in leading institutions in India and abroad what are your suggestions for improving satisfaction levels in careers in scientific research and teaching?

PN: Largely I view this from a personal angle. One must with a lot of deliberation decide what one values in life. If material success is a criterion then teaching and research may not be the best route to adopt. I know you will have examples of some very successful researchers but they are the exceptions. For those who find satisfaction in struggling with imponderables, are creative while observant, and can put in long hours of work in laboratories, research will be satisfying. Genuine encouragement in term of publicity and recognition in the peer group should be given for innovative works.

*Dream 2047:* Have you observed major differences in career choices between boys and girls of similar talents?

PN: The board examination results (both CBSE and the State) reflect very encouraging performances by girls both from urban and rural areas. Many of the girls do pursue science in their college years. However, very few girls come forward to appear in the talent search tests. This perhaps is a reflection of the attitude of the parents because the same families encourage

## Core programme

The Core Programme (Senior Scholarship Programme) of Jagadis Bose National Science Talent Search (JBNSTS) for undergraduate students is as old as the institution itself. Since the first batch of scholars were selected in 1960, more than 45 batches of scholars of basic sciences, engineering and medicine, have been identified and nurtured throughout their formative academic years. This programme is being supported by the Department of Higher Education, Government of West Bengal form its inception. The accumulated expertise and experience acquired through these years have given the institution a reputation that reaches far beyond the boundaries of West Bengal. Department of Science & Technology, Govt. of India and several other agencies have contributed towards extending the activities of this institute.

*Henry Ortiz, US Consul General, Dr. S. Kulkarni (a former JB-Scholar and currently Counsellor, US Embassy) and Director, JBNS*

their sons to appear for such tests. I may be deemed partial, but I think girls develop into better research scientists than boys.

*Dream 2047:* What are your suggestions and ideas for improving the image of research centers and universities?

PN: Setting up new engineering, medical science and basic science institutions has been neglected for many years. The recent investments in new educational institutions are therefore very encouraging. There will be teething problems including searching good faculty.

A large number of research institutes with all the infrastructural facilities are being built in areas of agriculture, medicine and fundamental science. There is private sector interest also, particularly in IT. There is, however, not much effort to upgrade the university research facilities, where the students have their first initiation into the world of research.

*Dream 2047:* What are your suggestions for improving coverage of science in the mass media and how would you describe the responsibilities of editors/ journalists?

PN: Some coverage is given on an irregular basis, especially in some of English dailies. This is generally based on inputs from abroad. Indian science gets noticed only when some sensational, generally negative, development occurs. Achievements of young scholars and students, work on society related issues and different science motivational programmes are very rarely highlighted. If science needs icons, the media has to be harnessed into service. See how sports and cinema develop such role models.

*Dream 2047:* Dr Nandy, I foresee that rural India will provide the next generation of scientists. Please comment.

PN: I give a very definite support to your hypothesis. The minds of rural kids are not inhibited by substandard coaching and tuition classes and thus they can think independently and innovatively. There communication skills are often weak but that can be developed.

*Dream 2047:* What are your suggestions for overhauling school syllabus and board examination system?

PN: Many expert committees have deliberated and given comprehensive recommendations. Some states and examination boards have incorporated far reaching changes based on such comprehensive reports. In general, I would like to say that

(a) Science syllabus should be more experiment oriented,
(b) Board examinations should not be abolished,
(c) Syllabus load should be reduced, and
(d) Science club/ eco clubs in schools should be encouraged.

*Teachers' Training Program at JBNSTS*

*Dream 2047:* Who are the role models beyond Dr APJ Abdul Kalam for the youth in the field of science or technology?

## Aims and objectives of JBNSTS

Aims and objectives of Jagadis Bose National Science Talent Search (JBNSTS), Kolkata are to motivate students to realise the importance of excellence in the scientific world and try to cultivate this in their own lives as students of science; to identify talented students of science, engineering and medicine who shall develop into scientists and technologists of very high abilities; and to nurture them through enrichment programmes to develop their talents.

*Pandit Jawaharlal Nehru awarded Papiya (nee Sengupta) Nandi with JBNSTS Scholarship 1960 at Rajbhavan on 11th April, 1961*

PN: It varies from person to person. I was very influenced by the life and achievements of Marie Curie in my youth. It could be one's teacher or even a neighbour who can be an inspiration.

*Dream 2047:* What skills are needed in a student to emerge as an active researcher? Can we help imbibe the right skills while they are still in high school?

A good researcher has to be ready for hard work including long hours in libraries, odd timings in laboratories and field visits to difficult places. Satisfaction will be in terms of unraveling some new facet, understanding some process, developing a new product or even none of these. Students therefore need:

(a) More exposure to motivational lectures,
(b) more interaction with scientists,
(c) frequent visits to science research laboratories,
(d) more opportunities to do hands-on experiments and see how science is happening, and
(d) life and stories of discoveries by scientists in their syllabus.

*Dream 2047:* Thank you very much for sharing your insights with our readers.

Thanks you for giving me an opportunity to put my views across. The time was most opportune since we are reviewing JBNSTS. ■

# Dinosaur dung and evolution of grass

T V Venkateswaran
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Once upon a time there were no flowers, no roses, no tulips to hold out to your love; no daffodils to adorn your hedge; no jasmine to deck your hair; nor any ponds crammed with lotus and lilies. Indeed flowers are so much a part of our daily lives that we take them for granted. Long long ago, the world consisted of monotonous cold dark green vegetation possessing no other colour. A short time before the close of the Age of Reptiles, at some wayward part of the Earth, there occurred a revolution first ever flowers bloomed; soon the flowering plants became dominant in the landscape on the four corners of the Earth; and the world was a riot of colours.

Today angiosperms, or flowering plants, constitute the dominant vegetation of the Earth's surface. Flowering plants outnumber the non-flowering by twenty to one. Angiosperms are found in varied environments. These are found in any land area, be it freezing poles or blistering desert. These occur abundantly in the shallows of rivers and fresh-water lakes, and in small numbers in salt lakes and in the sea. One should hasten to add that such aquatic angiosperms are not, however, primitive forms, but are derived from immediate land-ancestors. The range of angiosperms is also wide from familiar duckweed with no discernable stem or leaf but with simple root system, to towering trees with canopy which can host a small village meeting. In between the two extremes is every conceivable gradation, embracing aquatic and terrestrial herbs, creeping, erect or climbing in habit, shrubs and trees, and representing a much greater variety than is to be found in the other subdivision of seed-plants, the gymnosperms.

Palaeobotanists believe that sometime before 140 million years ago, flowering plants, i.e., angiosperms, diverged from non-flowering seed plants known as gymnosperms. Fossils of gymnosperms, such as pine trees and other evergreens, go back at least 350 million years. In those days cockroaches were as big as house cats and dragonflies were with the wingspans of modern hawks. Angiosperms appeared rather suddenly in the fossil record, just around the cretaceous period (about 145 million years ago). It implies the birth of flowering plants could have occurred anytime between 140 million and 350 million years ago.

Sure, botanists can narrow that gap by providing more serious clues and evidences; yet the mystery of flowering plants remains. In fact mosses were the first plants to emerge on land some 425 million years ago, followed by firs, ginkgoes, conifers and several other varieties of non-flowering types the gymnosperms. In fact, the Plantae, or plants, are one of the most abundant and diverse groups of organisms on Earth. With more than 2,50,000 species known, they are second only to arthropods. Plants have a rigid cell wall around each cell and produce their own food by capturing light energy in pigments like chlorophyll. They convert this energy into sugar, starch, and other foods that plants need to survive. Some fossils that appear to be from plants date back to the 488 million years ago (Ordovician), but the first unquestioned occurrences of plant fossils are from the 400 million years ago (Late Silurian). Gnetophytes seed-bearing plants that can grow as shrubs, trees, or vines and share similarities with both gymnosperms and angiosperms evolved subsequently.

*Dino dung*

From whence did flowering plant come? How were flowering plants able to diversify so much and spread so rapidly all over the world? How did flowering plants get to be so different from "primitive" land plants, such as mosses, ferns and conifers? The sudden appearance of flowering plants and its rapid colonisation of the entire world is an enigma that goaded even Charles Darwin to grant it as 'an abominable mystery'. In fact the puzzle remains as controversial today as ever.

Quite naturally one should turn to fossils for clues; take your shovels, pickaxe and microscopes.

## Fossils evidence

What we have is scanty fossils evidence left from the past to reconstruct at least a partial history of the flowering plant. In fact even today the evolutionary history of flowering plants is poorly known, represented by remnant fossils only weakly identified as angiosperms. Some of the earliest types of the flowering plants seem to have emerged about 130 million years ago, although some palaeobotanists have claimed fossil evidence as far back Jurassic while others have identified fossilised parts of the earliest flowering plants or angiosperms in 220 million-year-old Triassic sediments. Until recently, fossil evidences of early angiosperms were based on vegetative materials and pollen. None of these fossils,

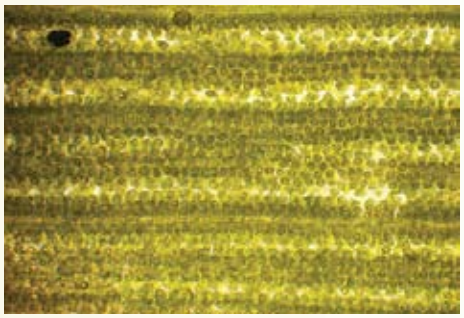
*Look at the landscape; no grass is depicted*

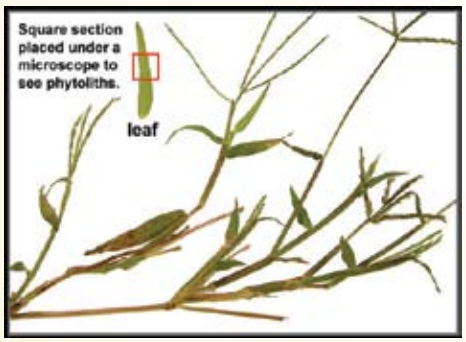
however, showed the presence of ovules or seeds enclosed in carpels, the true distinction of the angiosperm lineage. However, recently, scientists have discovered in China the oldest, most complete flowering plant fossil yet, with seeds enclosed in the carpels. The 125-million-year-old specimen belongs to a new plant family and provides clues as to how now extinct species gave rise to modern flowering plants. The study suggests that angiosperms the dominant vegetation in the world today perhaps evolved from aquatic, weedy herbs.

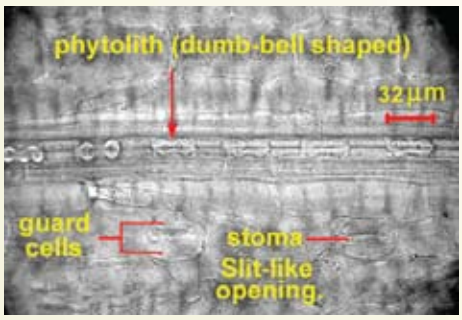
From what is available today as fossil record it appears that flowering plants abruptly appeared out of nowhere about 130 million years ago during the Jurassic period (203-135 million years ago). Based on current evidence, it seems that the ancestors of the angiosperms and the gnetophytes diverged from one another during the late Triassic (220-202 million years ago). Fossil plants with some identifiable angiosperm characteristics appear in the Jurassic and early Cretaceous era (135-65 million years ago), but in relatively few and primitive forms. Inferring from the rich fossil record we do know that by the late Cretaceous era, angiosperms appear to have become the predominant group of land plants. The angiosperms underwent a rapid radiation and by the end of the Cretaceous (65-70 million years ago) most flowering plant families had evolved. In fact it is during this time that many fossil plants recognisable as belonging to modern families (including beech, oak, maple, and magnolia) appear in the fossil record. At that time, there was an almost exponential increase in angiosperm diversity, and there does not appear to have been any major extinction of groups in between. Despite the large numbers of taxa that are known from rather early in this diversification, there is no indication of where the taxa are coming from.

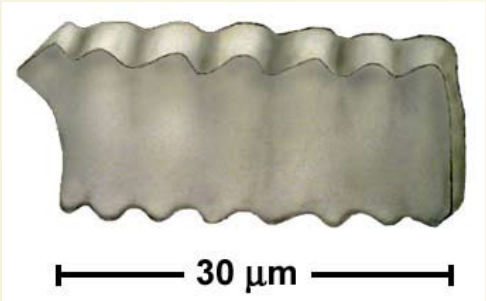
## Origin of grass

Take a look at pictures and illustrations depicting dinosaurs. You might find a lush forest of ferns, cycads and conifer but the land itself would be barren. Watch closely. The landscape is without grass, evoking eerie feeling. Yes, until recently, based on fossil records, grasses were thought to have evolved around 55 million years ago, after the age of dinosaurs. Grasses are considered relatively advanced flowering plants, and






*Specific shape of the phytolith gives the grass blade its characteristic sharpness*

most macrofossils and pollen from grasses appear long after the demise of dinosaurs at the end of the Cretaceous Period (65 million years ago).

Fossil records indicate that after the KT event (impact of meteor on Earth that killed dinos), grasses became widespread. Barren land became lush with grass. There were many reasons that grass became so successful. First of all, its roots protected the topsoil from blowing or being washed away by the forces of nature. It was able to take advantage of sunlight where trees and taller plants could not. Since grass was a flowering plant, its seeds were protected. And, the shorter roots could take up the water before other plant roots could absorb it. Obviously, grass had a tremendous effect on mammalian evolution.

## Clue from the dino dung

The conventional wisdom was challenged and yet another piece in the jigsaw puzzle of evolution was found when Vandana Prasad and her co-workers found phytoliths in the fossilised dung of sauropods that lived in central India about 65 to 71 million years ago. Caroline Strömberg of the Swedish Museum of Natural History, Habib Alimohammadian and Ashok Sahni of Birbal Sahni Institute of Palaeobotany, Lucknow working with Vandana has turned the clock back for grasses. Perhaps grass was there even during the age of reptiles after all.

Run your finger along the edge of grass and feel razor sharp edge. Phytoliths are what make a blade of a grass razor sharp. Phytoliths are microscopic silica bodies found inside the cells of stems and leaves of grasses. Depending on the species of grass, they range from 5 to 100 micrometres in length. Because they are made of a crystalline form of silica called opal, they are very durable and retain their characteristic shapes over millions of years. Different genera of grasses have phytoliths with unique shapes, including square, rectangular, oblong, bilobed, and wavy with undulate margins, butterfly and dumb-bell shaped. Like microscopic pollen grains and diatoms, the phytoliths remain perfectly preserved in spaces between soil particles. Phytoliths discovered in dinosaur dung (called coprolites), by Vandana go to establish that these enormous prehistoric herbivores fed on grasses.

Phytoliths have been an important factor in the evolution of grazing herbivores that feed exclusively on grasses. During the lifetime of an animal that consumes large quantities of grasses, its molars gradually wear down. These animals have evolved high-crowned teeth that in some cases continue to grow from the base as the crowns are worn away. Thus evolution of grass shaped / mediated the evolution of grazers. It is also pertinent to note that the phytoliths Dr. Vandana found in the dino's dung were similar to rice and bamboo; indicating perhaps Indian land mass was the site of origin of these plants. ■

# Ways to win over the **Common annoyances of pregnancy**

**Dr Yatish Agarwal**
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> "Man needs difficulties; they are necessary for health."
> —Carl Jung in *The Transcendent Function*

Minor difficulties are a common everyday event during pregnancy. Almost all pregnant mothers must pass through them. The key is not to let annoyances get the better of you. Overcoming the problems is easy provided you know the cause and ways to handle them.

You must also learn to recognise the red flags: when a minor problem threatens to loom large, it requires medical attention. At any time in the pregnancy, and for any reason, if you feel worried about something, the best course is to check with your doctor.

## Nausea and morning sickness

Nausea in the early weeks of pregnancy is a common occurrence. It affects eight in 10 pregnant women. But fortunately, less than 40 per cent mothers complain of vomiting. The symptoms can begin as early as in the fourth week, but generally disappear by the 12th to 14th week. However, some mothers are not that lucky and continue to suffer right up to the 20th week.

The intensity and pattern of symptoms varies in each person. While some simply feel overcome with nausea, others cannot digest anything and begin to throw up. Some feel the symptoms in the mornings; some at other times; some all day long. The exact mechanism of this symptom is not clearly known but the hormonal changes that occur during early pregnancy definitely play a major role.

### *What to do*

To find relief, try the following suggestions:

- Eat small meals within short gaps, instead of the usual three meals a day. Many mothers feel well with this small change in routine.
- If you feel worst first thing in the morning, eat a dry toast or plain biscuit before you get up.
- Avoid foods and smells that make you feel worse. If you are cooking for the family, choose menus that will suit you as well as them. For yourself, eat foods that make you feel better and are equally good for health.
- Try cold foods because they have less aroma than hot foods—the sense of smell is very acute during pregnancy.
- Wear comfortable clothes. Tightly bound clothing around the waist can make you feel worse.
- Distract yourself as much as you can — often nausea worsens the more you think about it.
- Severe vomiting is rare. If it is persists, you run the risk of dehydration and electrolyte imbalance. Contact the doctor. If necessary, she can arrange for a short stay in hospital to correct the fluid imbalance. It may also be necessary to exclude a urinary tract infection.
- If you develop nausea towards the end of pregnancy, visit your doctor for blood pressure and urine check-up.

## Indigestion and heartburn

During pregnancy many women discover that foods they normally enjoy now give them indigestion. One obvious solution is to avoid foods that cause the trouble. But make sure that your diet is still well balanced. In general, try eating smaller meals more often, and sit straight while eating. This takes pressure off your stomach.

Heartburn is more than just indigestion. It is a strong, burning pain in the chest caused by the abnormal relaxation of the valve between your stomach and the food pipe. This allows the stomach acid to pass into the food-pipe. Over 50 per cent of all pregnant women suffer from heartburn. The reasons are twofold: one, the growing baby pushes the stomach upwards, and two, the hormone of pregnancy (progesterone) relaxes the valve.

### *What to do*

- Heartburn is often brought on by large meals or lying flat. It, therefore, makes sense to try and break you meal into smaller, more manageable portions. You must also avoid lying flat or bending down after having a meal. Sit in a comfortable upright position, so that the food can progress to the small intestine. Also sleep well propped up, with the head of the bed raised.
- Drinking milk can also help. Keep a glass of milk by your side in case you wake with heartburn in the night.
- You may also try simple antacid mixtures or tablets such as magnesium

trisilicate. Avoid the regular heartburn tablets such as cimetidine, ranitidine and famotidine which are absorbed into the bloodstream and are therefore, not safe during this period.

## Dizziness

Pregnant women often feel faint. Bouts of dizziness can occur if you stand still after walking briskly or if you get up from a low chair or get out of bed in a hurry. They can also occur when you are lying on your back.

### *What to do*

- If you feel dizzy while standing, sit down quickly and wait for the spell to pass.
- If you are lying on your back, turn onto your left side. This particularly applies when the pregnancy is in the later stages. Turning to one side takes the pressure off the big vein (inferior vena cava) and produces immediate relief by increasing blood circulation.

## Headaches

With some pregnant women, headaches are a common complaint. This happens because of the hormonal changes in the body.

### *What to do*

- Avoid hot, stuffy surroundings. Rest and relax. Drink plenty of liquids. Bathe regularly and enjoy the coolness of water in any form. If the headache persists, you can take an ordinary paracetamol tablet, but not aspirin. Paracetamol is safe and does not harm the baby.
- If the headaches are frequent and bad, tell your doctor. During late pregnancy this may be a sign of high blood pressure or some other complication.

## Insomnia

Sometimes in late pregnancy, it can be difficult to get a good night's sleep. The discomfort is too much. Some women may have very vivid dreams during this period. Some of these dreams are rather unpleasant.

### *What to do*

- You should never let the bad horrible dreams prey on your mind. Recall pleasant events and think positive.
- Use lots of pillows. Try lying on one side with a pillow under your tummy and another under your top leg. If you cannot sleep well during the night, try to catch up on your rest during the day.

## Fatigue

In the early months of pregnancy you may feel not just tired but desperately exhausted. It can be hard to handle—especially with young children or a tiring job.

### *What to do*

Try and rest as much as you possibly can. Sometimes tiredness is the result of worry. If you know that you are worrying about something, it will help to talk about it–with your spouse, doctor, or a friend.

## Breathlessness

It is common to feel breathless during pregnancy. That is because your body has to breath harder in order to eject the carbon dioxide that your baby produces and passes into your bloodstream via the placenta. In late pregnancy, the uterus also pushes the diaphragm up allowing less room for the lungs to expand.

### *What to do*

- If you have breathlessness, accompanied by cough, chest pains, or episodes of fainting, it is best to consult your doctor.
- If you have asthma, make sure that it is well controlled. Inhalers can be used quite safely all through the pregnancy. In contrast, a bad asthma attack might reduce the baby's oxygen supply and can be dangerous.

## Excessive urination

Needing to pass urine often is an early sign of pregnancy and for some women this condition can last until delivery. It is not known exactly what causes it in early pregnancy, but later it is the result of the womb pressing on the bladder.

### *What to do*

- In early pregnancy you can do little except putting up with it. If it disturbs you and you have to get up during the course of the night, try drinking less fluids past 7 pm.
- Some women may find it helpful to rock backwards and forwards while on the toilet seat. This eases the pressure of the womb on the bladder and you are more likely to empty it properly.
- If you detect pain while passing urine, or pass blood, you may have a urinary infection. It is common to have cystitis in pregnancy. See your doctor about it.

## Abdominal pain

Often abdominal pains up the sides of the womb are due to stretching of the ligaments. These are not serious. Some women experience a severe discomfort just in front of the bladder where the pubic bones meet in the mid-line. Usually these bones are held together tightly by a strong ligament, but in pregnancy this softens and stretches to make more space in the pelvis. This may be discomforting, particularly while walking or exercising when the pubic bones tend to move in relation to each other.

### *What to do*

This will spontaneously settle after pregnancy. A caution: if the abdominal pain is severe or is accompanied by spotting or bleeding, you must consult a doctor immediately.

## Cramps

Cramps are very common during pregnancy, and they can be very painful. They occur usually at night, in the legs or feet. The cause is not really known, but may be caused by lack of calcium. You may therefore need calcium supplements.

### *What to do*

- Rub the muscles hard.
- It also helps to bend your foot upwards with your hand. Your spouse could do this for you if you cannot manage it.
- It may also help to go for a short walk or exercise your legs and feet in some other way just before going to bed to get the circulation going.

[This column is primarily intended to educate the reader about the basics, and the do's and don'ts in a medical situation, and not as a substitute for professional medical advice. Before starting any form of treatment, please consult your physician.]

# Two mathematics conferences ICWM and ICM-2010

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The month of August had a sort of Mathematics Festival in Hyderabad. In a way it was a treat for the public, in general, and budding mathematicians, in particular, especially for those engaged in mathematical research. The year 2010 has been very exciting for the mathematical community in India because it marks the centenary of the Indian Mathematical Society together with the Silver Jubilee year of Ramanujan Mathematical Society. To add to this jubilation, two international congresses, namely, the International Congress of Women Mathematicians (ICWM) and International Congress of Mathematicians (ICM-2010) were organised in Hyderabad during 17-27 August 2010.

The International Congress of Women Mathematicians (ICFWM) was held on 17-18 August at Hyderabad Central University. The conference was attended by nearly 200 delegates out of whom 50 were foreigners. Prof Syed Hasnain, the vice chancellor of HCU inaugurated the conference by traditional lighting of the lamp. Those who graced the occasion included Prof Ulrike Tillman (Oxford, UK), chair, the scientific committee of International Congress of Mathematicians; Prof S.G. Dani, Tata Institute of Fundamental Research, Mumbai and Chair, National Board for Higher Mathematics (NBHM), among others. Prof Tillman expressed her joy to have ICWM in India on the sidelines of ICM. Prof Dani, one of the key persons behind ICWM, talked about NBHM and further highlighted the fact that we have now reached a stage where women can be counted as major contributors to mathematics. Prof Hasnain recalled the contribution of women mathematicians of ancient times like Hypatia and more modern ones, like Sofia Kovalevskya. There were also topical lectures of colloquium style delivered by eminent speakers coming from France, UK, USA, Sweden, Denmark, China and India. The poster sessions organised in between the lecture sessions received a good response from the delegates. About 25 to 30 posters involving mathematical principles/ modifications were displayed two of them worth point out happen to be:

The first day's deliberations of ICWM concluded with a round-table seminar on "Women mathematicians around the world" The seminar was chaired by Beatrice Pallone. Eight speakers from developed and developing countries presented their views effectively by supplementing the statistical data. The sum and substance of their presentation was that the number of women in mathematics research or at the university level is scanty Vera Sipadel of Argentina mentioned that there is a total absence of women mathematicians in the National Universities. In India, the percentage of women in the institutes of higher strata like IIT, TIFR, etc., varies from 10 to 15%.

The reasoning behind this disproportion, as pointed out by the speakers, included (i) no role models before aspiring girls; (ii) lack of motivation at the early age; (iii) male heads of department discouraging girls from choosing mathematics at the graduate level; (iv) selection committees not being impartial while selecting the faculty; (v) prejudice and bias against women mathematicians.

The convention of ICM 2010, the most prestigious quadrennial event was held for the first time in India in over 100 years of ICM's existence. This meet attracted a large gathering of 3,000 delegates from over 90 countries together with about 1,000 Indians from different research institutions universities and colleges.

The convention was inaugurated by Smt. Pratibha Patil, the President of India, on 19 August. . In her inaugural address she stressed the need of studying mathematics, as it has spread its wings in various branches of science and technology. She further added that India could make tremendous development in post-independence era because of science. The most significant part of the opening ceremony was the announcements of the Fields Medals awarded to young scholars below 40, who have made valuable contribution. The Fields Medal is considered to be the highest recognition for achievement in mathematics; almost as good as winning a Nobel Prize in mathematics. John Charles Fields, (1863-1932), a Canadian mathematician, founded this prize, but he died in 1932 and the prizes came in force from ICM 1936. Until 1958 two medals were awarded at every ICM, but from 1962 up to the maximum of 4 medals are awarded. This year's winners are (i) Elon Lindenstrauss, Professor in Hebrew University; (ii) Neg Bao Chau, Professor, Chicago University, USA; (iii) Stanislav Smirnov, Professor, Geneva University, Switzerland; and (iv) Cedric Villani, Professor, Ecole Normale Supereure Delyon, France.

Besides Fields Medals three more prizes were awarded at the opening function.

- The Rolf Nevanlinna Prize (commemorating Rolf Harman Nevanlinna, a Finish mathematician of repute) for work in mathematical aspects of computer science was awarded to Daniel Spielman, Professor of Applied Mathematics and Computer Science at Yale University, USA.
- The Gauss Prize (commemorating the well known German mathematician Karl Fredrik Gauss) for outstanding mathematical contributions having significant applications outside mathematics was awarded to Yves Meyer, Emeritus Professor at Ecole Normes Superure Delyon, France.
- The Chern Medal (commemorating S.S. Chern, a Chinese mathematician who was a towering figure in geometry in the 20th century) was awarded for the first time at Hyderabad to Louis Nirenbery, Emeritus Professor Courant Institute of Mathematical Science, New York, USA.

All these prizes were given away by Smt. Pratibha Patil.

Leelavati Prize named after 12th century mathematical treatise *Leelavati* by Indian mathematician Bhaskaracharya was awarded to Simon Singh, a well-known physicist-turned British author, journalist and TV producer, who specialises in

# Nobel Prizes 2010

The Nobel Prizes in science for 2010 have been shared by six scientists for their achievements in different fields. The Nobel Prize in Physics for 2010 was awarded jointly to Andre Geim and Konstantin Novoselov, both of the University of Manchester in England, "for groundbreaking experiments regarding the two-dimensional material graphene." Graphene is a transparent, flexible and strong material made of single layers of carbon atoms that conducts electricity, making it an attractive material for a number of electronics applications.

*Andre Geim*

The Nobel Prize in Chemistry for 2010 has been awarded jointly to Richard F. Heck of University of Delaware, Newark, USA; Ei-ichi Negishi of Purdue University, West Lafayette, USA; and Akira Suzuki of Hokkaido University, Sapporo, Japan, "for palladium-catalysed cross couplings in organic synthesis". This chemical tool has vastly improved the possibilities for chemists to create sophisticated chemicals, especially organic chemicals that form the basis of life and is responsible for numerous fascinating natural phenomena such as colour in flowers, snake poison and bacteria-killing substances such as penicillin.

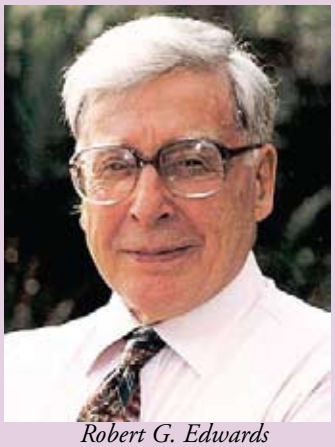
*Konstantin Novoselov*

*Ei-ichi Negishi*

*Akira Suzuki*

The Nobel Prize in Physiology or Medicine for 2010 was awarded to Robert G. Edwards, now professor emeritus at the University of Cambridge, UK, "for the development of in vitro fertilization". The technique of in vitro fertilisation, or IVF, which involves fertilisation of the ovum outside the body using the husband's sperms, has changed the life of thousands of infertile couples around the world who had had the joy of having their own babies using the new technique.

*Richard F. Heck*



*Robert G. Edwards*

[Details of the prizewinning works will be published in the forthcoming issues.]

popularising mathematical and scientific topics through his writings. In 1990 he joined BBC's 'Science and Features' department and in 1996 directed a BAFTA Award winning documentary 'Fermat's Last Theorem'. The Leelavati Prize was instituted by India for outstanding contributions to public outreach in mathematics by an individual. This prize was given away by Prof. Syed Hasnain, VC, Hyderabad Central University at the closing ceremony of ICM 2010.

At the ICM some 200 invited talks by outstanding experts were delivered. Also there were about 20 plenary lectures on diverse mathematical areas and sectional talks by outstanding experts addressed to other experts in specific areas describing recent important developments. On the sidelines of there was a chess match in which the world champion Vishwanathan Anand played against 40 mathematicians.

(S.P. Deshpande is retired professor of Mathematics. He has written several booksand articles on Mathematics.)

# Recent developments in science and technology

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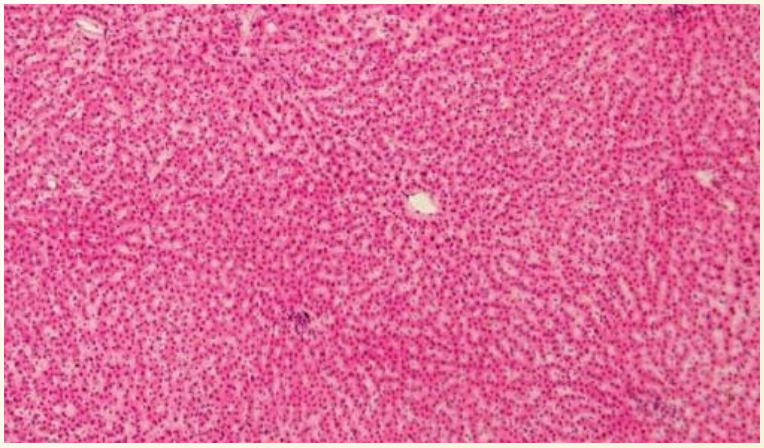
## Liver cells created from skin cells

Liver diseases kill lakhs of people in India every year. Hepatitis B alone accounts for an estimated 50 million chronic carriers who are at high risk of progressing towards a permanently damaged liver and cancer. Finding cure for liver disorders is extremely difficult because liver cells (hepatocytes) cannot be grown in the laboratory. Despite 40 years of trying, scientists have so far never been able to grow liver cells in a lab, making research into liver disorders extremely difficult. Now a team of scientists of Cambridge University led by Tamir Rashid have managed to create liver cells in a lab for the first time using reprogrammed cells from human skin. They were able to use stem cells produced by reprogramming to model a diverse range of inherited disorders, which paves the way for new liver disease research and possible cell-based therapy. The research was reported in the *Journal of Clinical Investigation* in August (J Clin Invest doi:10.1172/JCI43122).



*Human liver cells*

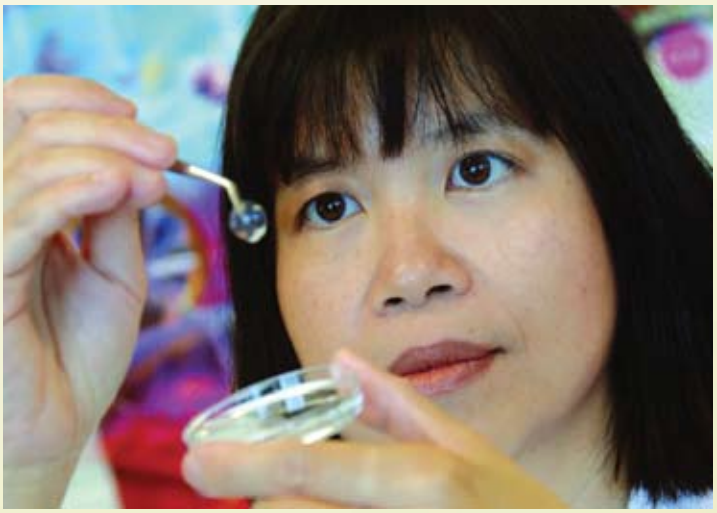
Normally, only embryonic stem cells are pluripotent; that is, endowed with the capacity to grow into any of the different types cells found in the body. But research on and use of embryonic stem cells have been banned in most countries on ethical grounds. Other types of cells of the body are all differentiated cells that have lost the capacity to develop into other types. For example, under normal circumstances skin cells can grow into only skin cells and not into any other type of cell. But the Cambridge researchers were able reprogramme skin cells and turn them into pluripotent stem cells using a technique developed four years ago and grow them into liver cells.

In 2006 a team of researchers led by Shinya Yamanaka of the University of Kyoto in Japan first succeeded in reprogramming mammalian somatic cells to behave like embryonic stem cells. They used four transcription factors, namely Oct3/4, Sox2, c-Myc, and Klf4 to make adult mouse cells behave like embryonic stem cells. Later, two teams of researchers – Kyoto University's Yamanaka and James Thomson of the University of Wisconsin, Madison, USA – reported creation of 'induced pluripotent cells' (iPCs) from human skin cells by using the same technique (*Science*, 23 November 2007). The transformed cells are indistinguishable from embryonic stem cells in morphology, proliferation, and gene expression.

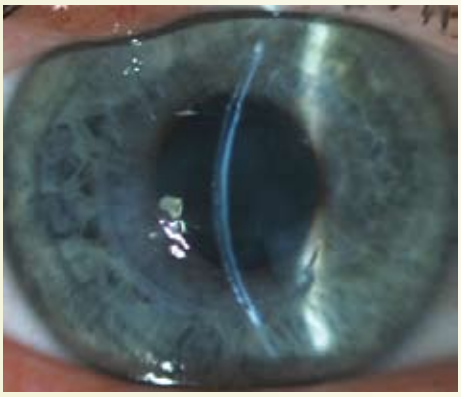
In the present study, the Cambridge group used the same set of four factors to turn human skin cells into induced pluripotent cells, which have similar properties as embryonic stem cells. The researchers used the reprogrammed cells to generate liver cells which mimicked the broad range of liver diseases in the patients the skin cells were taken from. They also used the same technique to create "healthy" liver cells from the control group. By making diseased liver cell available, the research paves the way for the potential development of new treatments for liver diseases that kill lakhs each year.

## Synthetic cornea created to restore vision

The cornea is a thin transparent layer of collagen and cells that acts as a window into the eyeball. It must be completely transparent to allow the light to enter and it also helps with focus. However, damage to the cornea and corneal disease, often make the cornea cloudy or opaque and are major causes of blindness globally. Corneal blindness can be cured by replacing the damaged cornea and corneas from human donors are used to replace damaged tissue and treat corneal blindness, but there is a severe worldwide shortage of donor corneas. A few years ago a team of researchers from USA, Canada and Sweden – May Griffith, *et al.* – developed biosynthetic corneas for trial on human patients. Now, two years after implanting them into patients, the synthetic corneas appear to be safe and have helped several people see more clearly (*Science*



*Dr. May Griffith displays a biosynthetic cornea that can be implanted into the eye to repair damage and restore sight.*



*A biosynthetic cornea, shown here two years after implantation, which allowed nerves in the eye to regenerate over time making the eye look normal. (Credit: Per Fagerholm and Neil Lagali)*

*Translational Medicine*, 25 August 2010 | DOI: 10.1126/scitranslmed.3001022).

Griffith and her colleagues began developing biosynthetic corneas in Ottawa, Canada, more than a decade ago, using recombinant human collagen produced in the laboratory and moulded into the shape of a cornea. (Recombinant human collagen is a viable replacement for naturally occurring human collagen that does not have the limitations of human donor tissue or animal-sourced collagens, such as risk of disease transmission and availability of donor supply.) After extensive laboratory testing, Griffith began collaborating with Per Fagerholm, an eye surgeon in Sweden, to provide the first-in-human experience with biosynthetic cornea implantation. Together, they initiated a clinical trial in ten Swedish patients with advanced keratoconus (a degenerative disorder of the eye affecting the cornea which causes substantial distortion of vision). Each patient had the damaged corneal tissue in one eye surgically replaced with a biosynthetic cornea made from synthetically cross-linked recombinant human collagen.

Over two years of follow-up, it was observed that cells and nerves from the patients' own corneas had grown into the implant, resulting in a "regenerated" cornea that resembled normal, healthy tissue. The patients in the trial did not experience any rejection reaction or require long-term immune suppression, which are complications that sometimes occur when human tissue is transplanted. The biosynthetic corneas behaved just like natural human corneas and were sensitive to touch. After two years, six of the patients' vision had improved, and when fitted with contact lenses, their vision was comparable to that of someone who had received a real human cornea transplant. According to the researchers, this study is important because it is the first to show that an artificially fabricated cornea can integrate with the human eye and stimulate regeneration. Griffith and her colleagues are planning a larger study with what they hope will be better implants that do not require sutures.

## Origin of Martian moon Phobos revealed

Mars has two small moons – Phobos and Deimos. The two moons are so small that their origin has been a long standing puzzle. It has been proposed that both moons may be asteroids formed in the outer part of the main asteroid belt (between Mars and Jupiter) and were subsequently captured by Mars' gravity. But recent studies provide firm indications that Phobos was formed relatively near its current location through re-accretion of rocky material blasted into Mars' orbit by some catastrophic event. (The Earth's Moon is also believed to have been formed by re-accretion of impact debris when a planetary body with roughly one-tenth the mass of Earth collided with our planet – commonly known as the Giant Impact Hypothesis.)

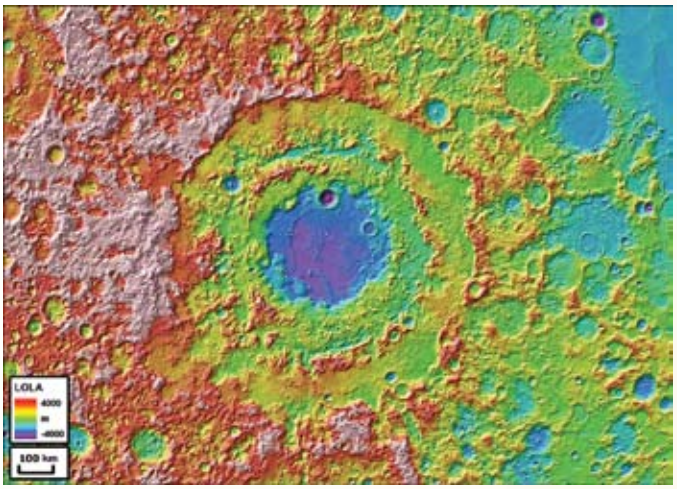
Two teams of researchers carried out compositional analyses of thermal infrared spectra of Phobos using ESA's *Mars Express* and NASA's *Mars Global Surveyor* missions, and arrived at very similar conclusions. The re-accretion scenario is further strengthened by the measurements of high porosity of Phobos by the instrument called 'Mars Radio Science Experiment' (MaRS) on board *Mars Express*. The results of these studies were presented by Marco Giuranna of Italy's Istituto Nazionale di Astrofisica and Pascal Rosenblatt of the Royal Observatory of Belgium at the European Planetary Science Congress held in Rome from 19-24 September 2010.

Previous observations of Phobos had suggested the possible presence of carbonaceous chondritic meteorites – carbon-rich materials commonly associated with asteroids. But the new thermal infrared observations from the *Mars Express* do not support this; instead they back up the 'in-situ' theory; that is, an origin within Mars. For the first time presence of a type of mineral called phyllosilicates was found on the surface of Phobos. (Phyllosilicates, or sheet silicates, are an important group of minerals that includes the micas, chlorite, serpentine, talc, and the clay minerals.) Other observations appear to match the types of minerals identified on the surface of Mars rather than objects from other relatively remote locations in the solar system, indicating that material of Phobos must have come from the surface of Mars. According to the researchers, the highly porous interior of Phobos, as observed by the MaRS team, further supports the re-accretion formation theory. A highly porous asteroid would have probably not survived if captured by Mars.

*Martian moon Phobos*

## New light on Moon's geological past

In the past couple of years there have been several new discoveries about the Moon the most important being the finding of water on the Earth's only natural satellite. Three papers published the journal *Science* (17 September 2010) throw new light on the Moon's geological past. They show that the Moon was bombarded by two distinct populations of asteroids or comets in its youth, and its surface is more complex than previously thought. The conclusion is based on data from the 'Diviner Lunar Radiometer' Experiment aboard NASA's *Lunar Reconnaissance Orbiter (LRO)*, an unmanned mission launched in 2009 to comprehensively map the entire Moon. The spacecraft has




*Roughly 900 kilometres across, the large multi-ringed basin Orientale stands out dramatically in this topographic map created by the Lunar Orbiter Laser Altimeter. (NASA / LOLA team)*

been circling about 50 kilometres above the Moon's surface for the past year.

Now a team led by Brown University planetary geologists, using data from the Lunar Orbiter Laser Altimeter (LOLA), one the instruments on-board *LRO*, has produced the first uniform, comprehensive catalogue of large craters on the Moon that could shed light on the full-scale, planetary bombardment that characterised the inner solar system more than 4 billion years ago. The team identified and mapped 5,185 craters that are 20 kilometres in diameter or larger. The new data reveal previously unseen differences in composition in Moon's crustal highlands where most of the craters are found. The *LRO* data have also confirmed the presence of material surprisingly high in silica – a compound containing the chemical elements silicon and oxygen ($SiO_2$) – in five distinct lunar regions.

The first paper in *Science* describes results obtained from a detailed topographic map of the entire lunar surface created using *LRO*'s LOLA instrument, which clearly bring out the difference between older highland impactor population and the younger population in the lunar 'maria' – giant impact basins filled with solidified lava flows. According to James Head, lead author of the paper, the greater density of large craters compared to smaller ones in the highlands, implies that the earlier population of impactors (objects which collide with another body) had a proportionally greater number of large fragments than the population that characterised later lunar history. According to the researchers, these findings will help geologists in better understanding of the meteorite bombardment history of Earth.

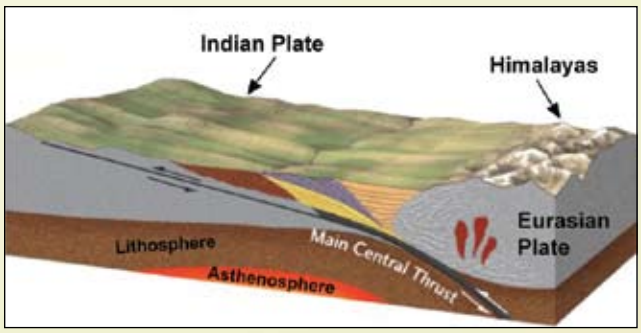
In the other two *Science* papers, researchers describe how data from the Diviner Lunar Radiometer Experiment instrument on *LRO* reveal the complexity of the geological processes that forged the lunar surface. The data have revealed previously unseen differences in composition in the crustal highlands, and have confirmed the presence of anomalously silica-rich material in five distinct regions. The silica-rich minerals include quartz, potassium-rich, and sodium-rich feldspar – minerals that are only ever found in association with rocks that have undergone extensive magmatic processing. According to the scientists, the detection of silicic minerals at these locations is a significant finding, as they occur in areas previously shown to exhibit anomalously high abundances of the element thorium. The *LRO* data also confirmed that the 2,500-kilometre diameter South Pole Aitken Basin, which lies between the Moon's south pole, is the Moon's oldest impact structure.

## New facts about Himalayan origin revealed

The Earth's surface (lithosphere) is known to be composed of a set of large and small continental plates, that rests on and slides over an underlying, softer layer of partially molten rock known as the asthenosphere. While the interior of the moving plates remain essentially undeformed, their boundaries are subject to extreme pressures and are the sites where violent processes like earthquakes and volcanic eruptions occur. Where two plates collide the resulting pressure is often so great that it deforms the surface into folds leading to formation of high mountain ranges.

Recent seismic studies by a team of scientists at the GFZ German Research Centre for Geosciences has revealed that during the collision of India with the Eurasian continent some 50 million years ago, the Indian plate was pushed about 500 kilometres under Tibet, reaching a depth of 250 kilometres. The result of this largest collision in Earth's history is the world's highest mountain range, the Himalayas, and the Tibetan Plateau. As the plates collided, it created a series of long, parallel folds in the Earth's crust, and in this stupendous upthrust was created a mountain range that contains all the world's mountains over 7,000 metres in height. The recurring catastrophic earthquakes in China are also caused by this collision of two continents. The entire Indian sub-continent has been moving continuously north over millions of years and has moved two metres below Tibet in the last 50 years alone.

The researchers used a new seismic method to investigate the collision process by following the route of the approximately 100-kilometer-thick Indian continental plate beneath Tibet. To achieve this, a series of large seismic experiments was carried out in Tibet, during which the naturally occurring earthquakes were recorded. By evaluating weak waves that were scattered at the lower edge of the continental plate, the researchers were able to make this edge visible in detail. Analysis of the results showed that the boundary between the rigid lithosphere and the softer asthenosphere was much more pronounced than was previously believed. According to the researchers, the large international seismic experiments in Tibet have generated quality data in large quantities and have led to a much improved understanding of the collision of two continental plates and their resulting deformations. ■




*Formation of the Himalayas by collision of the Indian Plate with the Eurasian Plate.*

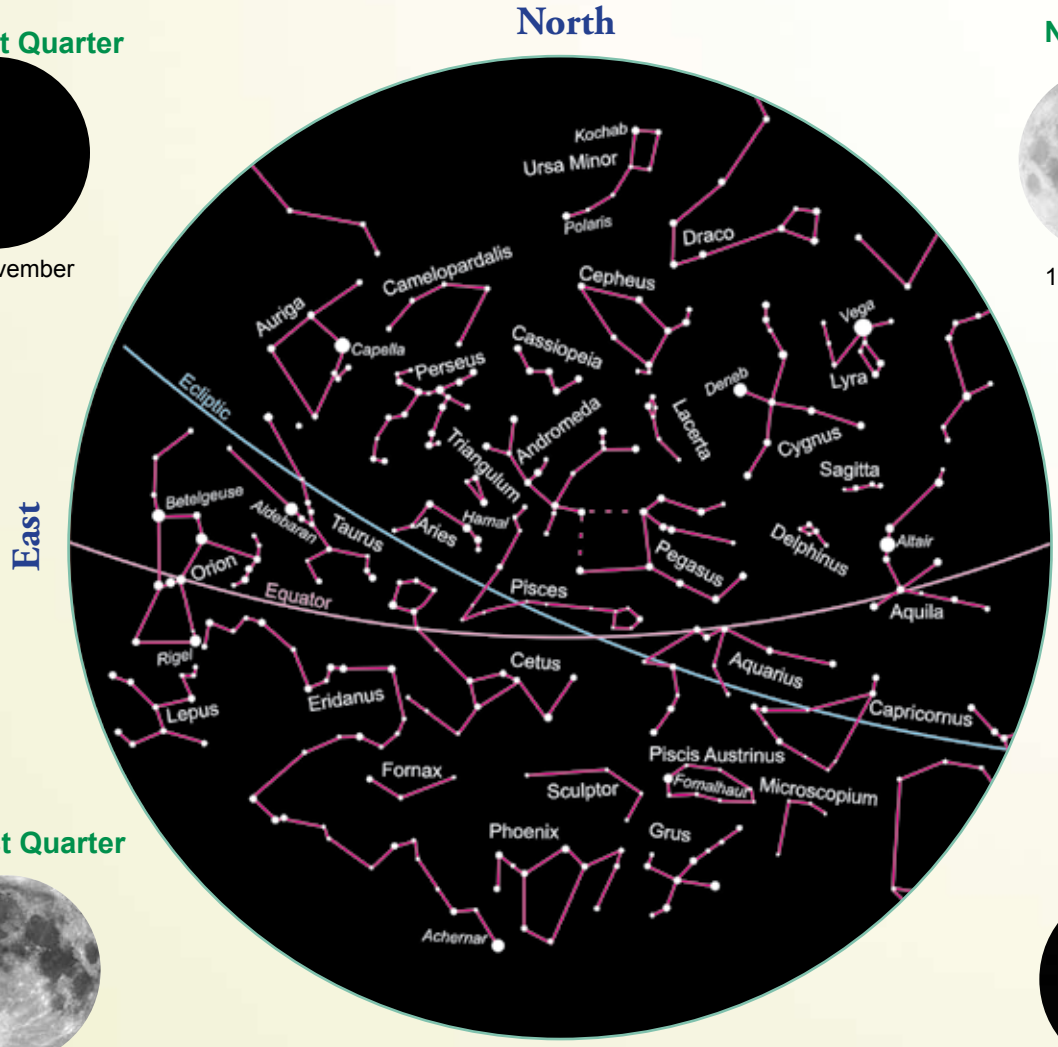
# Sky map for November 2010

**Moon-Last Quarter**

06 November

**New Moon**

13 November




**Moon-First Quarter**

21 November

**Full Moon**

28 November

The sky map is prepared for viewers in Nagpur (21.090 N, 79.090 E). It includes constellations and bright stars. 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 northen horizon. Similarly, for viewer north of Nagpur, constellations of northern sky will appear 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 November, at 9 PM on 15 November and at 8 PM on 30 November.

## Tips to use sky map

(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 constellation as shown in the map one by one.

## Visibility of planets** (IST)

| | Rising | Setting | In the Zodiac |
|---|---|---|---|
| Mercury | 07:41 | 18:29 | Libra- Scorpius-Sagittarius |
| Venus | 04:36 | 15:59 | Virgo |
| Mars | 07:58 | 18:47 | Scorpius-Sagittarius |
| Jupiter | 14:18 | 02:13 | Aquarius |
| Saturn | 03:13 | 15:25 | Virgo |
| Uranus* | 14:26 | 02:27 | Pisces |
| Neptune* | 12:48 | 00:13 | Capricornus |

**Time shown is subject to vary (± 1 hr) from place to place.
*Not naked eye object

## Sky event

| Date | IST | Event |
|---|---|---|
| 01 | | Venus begins a dawn apparition |
| 02 | | Mercury begins an evening apparition |
| 03 | 22:22 | Moon at perigee |
| 15 | | Jupiter near the Moon |
| 15 | 21:47 | Moon at apogee |
| 18 | 00:52 | Leonid shower |
| 19 | | Conjunction of Mars and Mercury |

**Arvind C. Ranade**
E-mail : rac@vigyanprasar.gov.in

# Your opinion

*Dream 2047* has been inviting your opinion on a specific topic every month. The reader sending the best comments will receive a popular science book published by VP. Selected comments received will also be published in *Dream 2047*. The comments should be limited to 400 words.

This month's topic:

**"Can the standard of school education be raised by adopting a single curriculum for the entire country?"**

Response should contain full name; postal address with pincode and email ID, if any; and should be accompanied by a recent passport size photograph. Response may be sent by email (opinion@vigyanprasar.gov.in) or by post to the address given below. If sent by post, "Response: *Dream 2047* November 2010" should be clearly written on the envolope.

**Vigyan Prasar**
A-50, Institutional Area, Sector-62, Noida 201 307 (U.P.)
Phone: 91-120-240 4430/35 Fax: 91-120-240 4437
Email: info@vigyanprasar.gov.in Website: www.vigyanprasar.gov.in

## Winners of "Your Opinion" contest for August 2010

### Topic: "Can battery operated vehicles provide a viable alternative to petrol or diesel driven vehicles in view of the rising cost of fuel?"

**V. Sridharan**
PGT Physics
Govt. Hr. Sec. School,
Sembakkam 603 108 (T.N.)

Since the efficiency of battery operated cars is less in terms of load and distance ratio, they are being used for shorter distances or with less commuters. We can overcome the increasing cost of fossil fuels and related energy crisis, if we increase public awareness, and availability of government loans with moderate interest for one time initial investment on battery operated vehicles. This can also be achieved by restricting the number of vehicles that use petrol or diesel in a locality and making some minimum number of battery operated vehicles mandatory for every sector.

*****

**Abhay Bhisikar,**
PHPMS, G-16, ADL Building,
RRCAT, PO: CAT,
Indore – 452 013 (MP)

Today the cost of fossil fuels such as petrol and diesel are rising day by day owing to the rising demand for these fuels worldwide. Researchers have found the alternatives for these fuels. Batteries can be used to operate vehicles, which at present mostly run on fossil fuels. Battery-operated vehicles can provide low-cost and pollution-free alternatives to fossil fuel powered vehicles. At present battery-operated vehicles have high initial cost, but in long run they will be economical owing to their low maintenance cost. Improved batteries for vehicles can reduce our dependence on conventional fuels such as petrol and diesel, which are becoming costlier by the day.

*****

**Varad Pradeep Bende**
Std X, Sadhna High School, Degloor
Dist- Nanded 431717,
Maharashtra
e-mail: varad93@gmail.com

Battery operated vehicles can provide a viable alternative to petrol or diesel driven vehicles view of rising costs of the fuel. The option of battery operated vehicles is affordable both from economical and environmental point of view. While vehicles driven by petrol or diesel emit pollutants like carbon monoxide and nitrogen oxides, battery operated vehicles do not emit any polluting gases and provide a cleaner alternative.

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# Regional workshop on Innovative Experiments in Physics

Vigyan Prasar has planned five regional workshops on Innovative Experiments in Physics during 2010–11. The first three day workshop was organised for the northern region in Chandigarh, in association with Punjab State Council for Science and Technology (PSCST) during 14–16 September 2010. Forty-three teachers from northern states of India attended the workshop.

*Participants doing hands-on activities*

Prof Satya Prakash, President, Indian Association of Physics Teachers (IAPT) was the chief guest at the inaugural function. Other dignitaries present were Professor K. K. Bhutani, Director, National Institute of Pharmaceutical Education and Research (NIPER); Dr V. B. Kamble, Ex-Director, Vigyan Prasar, and Dr. Neelam Gulathi Sharma, Associate Director, PSCST. Shri Rintu Nath, Scientist, and Shri B. K. Tyagi, Scientist represented Vigyan Prasar.

Shri B. K. Tyagi gave a presentation on Vigyan Prasar's programmes and activities to the participants and explained how they could be associated with different initiatives of Vigyan Prasar. He also gave a presentation on VIPNET science clubs and explained how to form a Science Club.

Shri Rintu Nath and Dr. M. S. Marwah conducted the workshop and demonstrated about 80 innovative activities/experiments

*Demonstration of innovative physics activities*

during the three days. Participants did hands-on activities during the workshop. Each participant assembled one kit to perform innovative activities. Using the kit about 20 activities can be performed. After each session participants interacted with resource persons, shared their opinion and performed the activity shown by the resource persons. In one session participants demonstrated innovative activities developed by them. A CD on 'Innovative Experiments in Physics' developed by VP was given to all the participants.

Dr. V. B. Kamble gave a talk on emergence of modern physics. Dr. Kamble and Shri Rintu Nath demonstrated the 'Modern Physics Kit'. All participants were given one kit and they performed all the activities during the demonstration.

Shri Rintu Nath performed a few experiments based on the PC interface

*One of the participants demonstrating innovative activities developed by him*

developed by Vigyan Prasar and explained how new projects can be designed using the kit.

In one session, a set of questions were given to all the participants. The possible answers were discussed and written by the participants. The experiments, based on the questions were performed after that and participants were allowed to do the experiments. The participants wrote their observations after the experiments. Participants, in general, felt that hands-on activities/experiments help in understanding the concepts better and make the subject interesting.

## "Medini Puraskar"

The Minister of State for Environment and Forests, Shri Jairam Ramesh presented the "Medini Puraskar" to Shri Navneet Kumar Gupta, Project Officer (EduSat), VP, for his book's *Global Warming Ka Samadhan: Gandhigiri* at the 'International Ozone Day' celebrations in New Delhi on 16 September 2010. He was awarded the first prize, which carries Rs.31,000 in cash and a citation. The "Medini Puraskar Yojana" was started by the Ministry of Environment and Forests to promote original Hindi book writing on environment and related subjects like forests, wildlife, pollution, and water resources.


*Shri Jairam Ramesh, Minister of State for Environment and Forests presenting the Medini Puraskar to Shri Navneet Kumar Gupta of VP*

Dr N.K Sehgal, former Director, Vigyan Prasar, have 91 books on physics which he would like to donate to interested school/college/ libraries. List of books can be seen on Vigyan Prasar's website: www.vigyanprasar.gov.in.

Interested schools/colleges can select the books and may contact on kapil@vigyanprasar.gov.in. The mailing cost will require to be borne by the interested parties.