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Fossils tell the tale of life on Earth

Fritz Haber

The discoverer of the synthesis of ammonia from its elements



(1868-1934)

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Climate Change: War At Your Doorstep



The issues of generation, conversion, reduction and sequestration of green house gases have been the subject of intense research and development for the past few years. The varying potential of different activities in contributing to the problem or the solution is debated hotly at different forums. The role of particulate matter, factory emissions and aerosols in impacting on the solar radiation received and reflected is being better understood.

Debates in the scientific community continue on anthropogenic and natural factors and the potential contribution possible from each towards the escalating and accelerating the impact of climate change. The experts can continue to argue using more and better models projecting the likely changes and the causative factors. This knowledge will be important in working out a consensus at the global level.

Climate in the next fifty years is likely to be a very significant player in the process of development. 'Business as usual' approach can accelerate the process and responsible behaviour by all players – state, industry, commerce, research, etc., can help delay the onset and/or soften the impact. Industry leaders need to reflect climate change impact when they exercise options and investments they firm up. There is adequate expertise available in the organised sector to support wise decision- making.

Industry has bigger responsibility and also access to resources for improving energy efficiency, reducing wastes and recycling water. Civic organisations have to adopt measures for municipal waste treatment and recycling water. Incentives including recognition of good performance may encourage better practices.

There is no emphasis needed to understand that investment in energy generation is coupled to environment. Integrated energy solutions using alternative non-carbon sources need promotion at many levels to become commercially successful. Clean fuel concepts are as much desired for a rural household as for the unorganised sector or for the large petrochemical complex. Are adequate numbers of R&D teams deployed on such priority projects? Can civil society raise a demand for investing more resources for more research and faster development?

There is an emerging new discipline that understands and explains the science of climate change. Students gain familiarity with assessment and measuring of changes in the precipitation of rain and snow, time scale changes of surface temperatures, understand consequences of significant factors both natural and man-made. Identification of vulnerabilities and steps to reduce risks will be necessary component of such studies requiring multi-disciplinary skills.

Every concerned citizen also needs to understand the core of the arguments and how global warming and climate change impair development. There is a constant worry among the lay persons. If the climate change issue is so urgent and massive, can individuals or the community do anything meaningful?

At one level, an outreach campaign can explain the greenhouse phenomenon, ice core and tree ring studies that establish periods of earlier climate change and early evidence of climate change and its consequences. 'Trigger' films will be very significant for most audiences. PC based games would attract the youth and help internalise the significant factors and their short- and long-term consequences. Life style changes to impact on emission and consumption patterns may be necessary not only for citizens of the developed countries but the privileged sections of the society in the developing countries also. This will enable informed discussion and prepare the community for adaptation measures.

Action by families and communities can reflect concern for the issues and also become small but meaningful steps in the adaptation and mitigation efforts. Selective planting of herbs and vegetables in the backyard in rural areas or on terraces and balconies in urban areas can help supplement nutrition in one's diet, reduce frequency of visit to the market, and sequester greenhouse gases. Planting selected trees on farm boundaries can limit soil and crop damage due to strong winds, help store carbon dioxide, and yield biomass, etc. Campaigns for outreach then have a clear agenda addressing urban citizens, rural leaders, or industry captains. Communicators should rise to this challenge and view it as an opportunity.

□ Anuj Sinha

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Fritz Haber

The discoverer of the synthesis of ammonia from its elements

"Haber is one of the most controversial scientific personalities of the last century—as perhaps best expressed by his motto that a scientist should serve mankind in times of peace but the fatherland in war."

Petra Werner in *"The Oxford Companion to the Modern History of Science"*,
edited by J. L. Heilbron (2003)

"...the Haber-Bosch process made about 10^8 tonnes of ammonia annually by the 1980s. About 80% of this is used to make fertilisers. In the First World War it also solved the problem of making explosives for Germany, since nitric acid (essential for their production) can be made by oxidizing ammonia."

The Cambridge Dictionary of Scientists (2nd edition, 2002)

"Haber became an authoritative advocate of collaboration between science and industry. During the 1920s he built up his laboratory into probably the world's foremost unit for the study of physical chemistry and its applications in industries. He attracted many scientists including a large number of foreigners who were later to enrich the physical sciences."

Hinduja Foundation Encyclopaedia of Nobel Laureates (1901-1987)
by Asoke K. Bagchi (1990)

Fritz Haber was a German chemist, a scientific administrator and a statesman. He is best known for his discovery of the process for synthesising ammonia. Haber was awarded the 1918 Nobel Prize in Chemistry for his synthesis of ammonia from its elements nitrogen and hydrogen, as the starting point for the production of chemical fertiliser. The award was retrospectively given in 1919. At the beginning of the 20th century the chemical synthesis of ammonia from its elements was a major challenge before chemists. It was of great economic importance, as ammonia was an essential ingredient for production of fertiliser and explosives. Chilean nitrate was the only major source for nitrogen fertiliser. The demand far exceeded the supply. It became obvious that if the world continued to rely on Chilean nitrate deposits to provide nitrogenous fertiliser for agriculture, famine was inevitable. Haber solved the problem of ammonia synthesis in 1908. The process was modified by Carl Bosch (1874-1940) around 1913 for large scale industrial production (and hence it is called Haber-Bosch process) and it still remains the main industrial method for the fixation of nitrogen. The synthesis of ammonia is a classic example of



Fritz Haber

how science can be a friend or foe depending on how it is used. The synthesis of ammonia has saved millions from hunger through increased food production. The Haber process now produces over 100 million tonnes of nitrogenous fertiliser per year. The ammonia synthesis is also responsible for killing millions in war. If there were no



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Haber process then Germany could not have managed a substitute for Chilean nitrate. In that case perhaps the First World War would not have been prolonged for so long.

Haber jointly with Max Born (1882-1970) proposed the Born-Haber cycle as a method for evaluating the lattice energy of an ionic solid. Haber is often described as the "father of chemical warfare" because of his work in developing and deploying chlorine and poisonous gases on large scale during the First World War. It may be said that Haber was an engineer by training and a scientist by vocation. He once said: "It is not enough to seek and to know; we must also apply."

Haber was born on 9 December 1868, at Breslau, now Wroclaw in Poland. His father Siegfried Haber was a dye merchant and chemical trader. His mother was Paula Haber. After studying three years at the primary school, Haber joined the St. Elizabeth Gymnasium, a classical school, where he studied for nine years. The curriculum followed at the Gymnasium was centred around humanities where students were required to learn Latin, Greek, literature and philosophy. His school education made him interested in literature and philosophy, an interest which he nurtured throughout his life. He admired Johann Wolfgang Goethe (1749-1832), the celebrated German poet and dramatist and Immanuel Kant (1724-1804), the famous German philosopher.

During 1886-1891, Haber studied at the University of Heidelberg under Robert Bunsen; at the University of Berlin (later renamed as the Humboldt University of Berlin) under August Wilhelm von Hofmann (1818-1892), and at the Technical College of Charlottenburg (later renamed as the Technical University of Berlin) under Carl Theodore Liebermann (1842-1914). After completing university education he worked for sometime at his father's chemical business before moving to the Swiss Federal Institute of Technology in Zurich to work with Georg



Carl Bosch

Lunge (1839-1923). After finally deciding that he would pursue a career in science Haber went to the Jena University to work with Ludwig Knorr (1859-1921). There he spent about six months and published a joint paper on diacetosuccinic ester. In 1894, he accepted the assistantship offered by Hans Bunte (1848-1925), Professor of Chemical Technology at the Technische Hochschule in Karlsruhe. He started working simultaneously on thermodynamics and electrochemistry. He was made professor of physical chemistry in 1898. He wrote two textbooks: *The Theoretical Basis of Technical Electrochemistry* (1898) and *The Thermodynamics of Technical Gas Reactions* (1908). These were pioneering works and had considerable influence on teaching and research.

While in Karlsruhe, Haber started working on ammonia synthesis in 1900 and solved the problem in 1908. Ammonia consists of two elements, nitrogen and hydrogen. The air we breathe has plenty of nitrogen. In fact about 78.1 of the air is nitrogen gas. Though apparently the synthesis of ammonia appeared to be a simple chemical problem, when chemists tried to achieve the synthesis it proved to be a seemingly impossible task. Nitrogen gas is relatively nonreactive because nitrogen molecules are held together by strong triple bonds. Before Haber showed the way many chemists unsuccessfully tried to produce ammonia from its elements.

Haber in his Nobel Lecture beautifully summarised the background of the problem and how he achieved it. Haber said: "We are

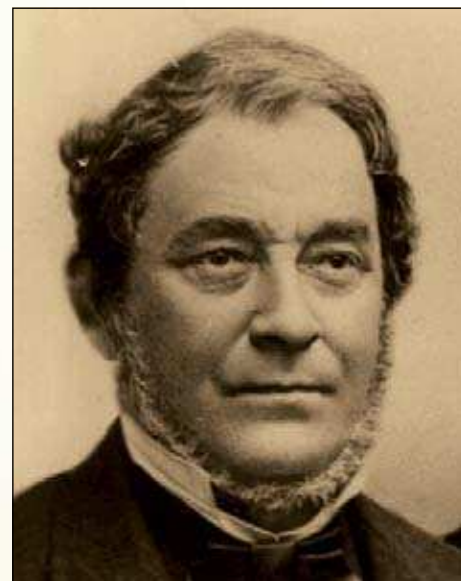
concerned with a chemical phenomenon of the simplest possible kind. Gaseous nitrogen combines with gaseous hydrogen in simple quantitative proportions to produce gaseous ammonia. The three substances involved have been well known to the chemist for over a hundred years. During the second half of the last century each of them has been studied hundreds of times in its behavior under various conditions during a period in which a flood of new chemical knowledge became available. If it has not been until the present century that the production of ammonia from the elements has been discovered, this is due to the fact that very special equipment must be used and strict conditions must be adhered to if one is to succeed in obtaining spontaneous combination of nitrogen and hydrogen on a substantial scale, and that a combination of experimental success with thermodynamic considerations was needed.

It was particularly significant that earlier attempts had not succeeded, even fleetingly, in achieving with absolute certainty a spontaneous union of nitrogen and hydrogen to form ammonia. This gave rise to the prejudice that such a production of ammonia was impossible, and in the course of time this enjoyed considerable support in chemical circles. Such prejudice leads one to expect pitfalls which, far more than clearly-defined difficulties, deter one from becoming too deeply involved in the subject."

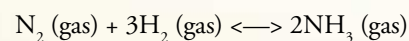
Haber, in an attempt to solve the problem of the synthesis of ammonia began investigating the reaction:



Max Born



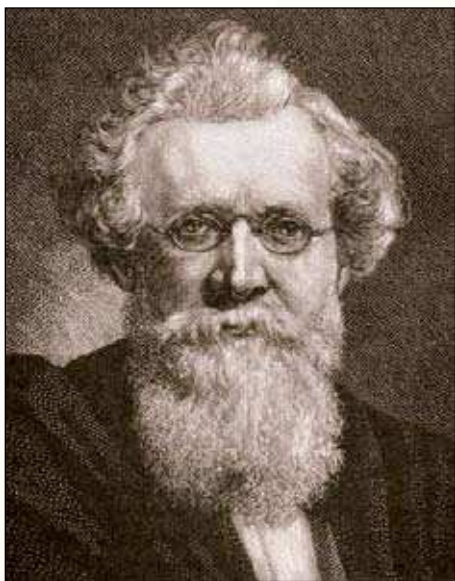
Robert Bunsen



Under normal conditions the yield is very poor. Haber demonstrated that practical yields could be achieved at high temperature and pressures using a catalyst. The need of high temperatures and pressures will be obvious when we realise that there are two opposing considerations in this synthesis. The reaction is an exothermic reaction that proceeds with a decrease in volume. The reaction rate is very slow at room temperature and by increasing temperature the rate can be increased. But the reaction is exothermic and according to Le Chatelier's principle increasing temperature will favour the reverse reaction. This means that very high temperature cannot be used otherwise the amount of product will drop dramatically. At the same it was obvious that an increase in pressure would favour the forward reaction as four moles of reactants produce two moles of the product. The catalyst has no effect on the position of chemical equilibrium but it provides an alternative pathway with lower activation energy and hence increases the reaction rate.

Carl Bosch upgraded the Haber process for industrial production around 1913. It still remains the main industrial method for nitrogen fixation. Carl Bosch was awarded the Nobel Prize in Chemistry in 1931 jointly with Friedrich Bergius (1884-1949) "in recognition of their contribution to the invention and development of chemical high pressure methods."

It is interesting to know what actually influenced Haber to take up the problem of



Wilhelm von Hofmann

the synthesis of ammonia from its elements. To quote Haber: "A narrow professional interest in the preparation of ammonia from the elements was based on the achievement of a simple result by means of special equipment. A more widespread interest was due to the fact that the synthesis of ammonia from its elements, if carried out on a large scale, would be a useful, at present perhaps the most useful, way of satisfying important economic needs. Such practical uses were not the principal purposes of my investigations. I was never in doubt that my laboratory work would produce no more than a scientific confirmation of basic principles and a criterion of experimental aids, and that much would need to be added to any success of mine to ensure economic success on an industrial scale. On the other hand I would hardly have concentrated so much on this problem had I not been convinced of the economic necessity of chemical progress in this field, and had I not shared to the full Fichte's conviction that while the immediate object of science lies in its own development and its own development, its ultimate aim must be bound up in moulding influence which it exerts at the right time upon life in general and the whole human arrangement to things around us."

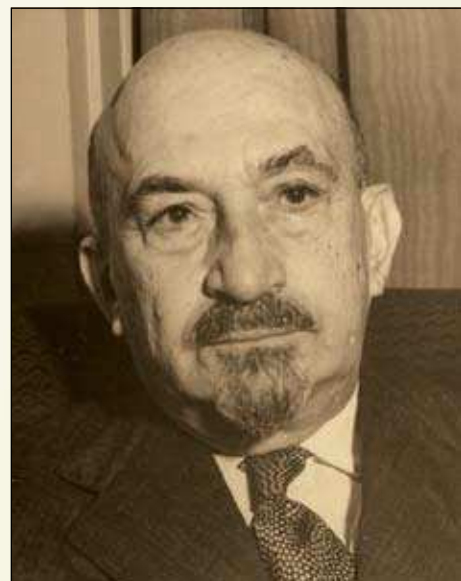
In 1911, Haber became the first Director of the Kaiser-Wilhelm Institute for Physical and Electrochemical Chemistry at Berlin-Dahlem, where he devoted himself fully to develop chemical weapons. It was Haber who on 22 April 1915 ordered the release of chlorine gas from 6,000 cylinders

on 30,000 Allied troops spread over a distance of 7 kilometres at Ypres, France. The result shocked the whole world. Within 15 minutes of the release of the gas 5,000 soldiers died and another 10,000 were seriously wounded. Haber's wife committed suicide and his son called him a rogue. Apparently Haber was not moved by these developments as he continued to develop chemical weapons. At the end of the First World War Haber and also Walter Nernst were arrested as war criminals but they were subsequently released because of their vast reputation as scientists. Based on his research on poison gas Haber observed that exposure to a low concentration of poisonous gas for long time often had the same effect on human beings as exposure to a high concentration. Both the processes can lead to death. He went on to develop a mathematical relationship between the gas concentration and the necessary exposure time, which is known as Haber's rule. It is said that Haber did not find the use of poison gas for causing death as inhuman. Rather he defended gas warfare by saying that death was death, by whatever means it was inflicted.

Haber's war-time research work served his country in many ways. During the war the supply of essential materials was a serious problem. Toluene, which was used as antifreeze in benzene motor fuel, was not available in Germany. Haber and his group working at Kaiser-Wilhelm Institute demonstrated that toluene could be replaced by xylene and naphtha as antifreeze in benzene motor oil and which were available in Germany. This greatly helped Germany in



Georg Lunge



Chaim Weizmann

its war effort as German machinery could be run by using xylene and naphtha.

When finally Germany was defeated Haber felt that in some way he was himself was responsible for his country's failure. To lessen the burden of enormous war debt of the German state Haber attempted to develop a process of extracting gold from sea water. He published a number of research paper on the subject. However, after working hard he realised that though a huge amount of gold was present, it was at such a low concentration (much lower than reported by earlier researchers) that no economically viable process could be developed to extract it. Haber failed to obtain gold from sea water, but his attempt paved the way for the extraction of bromine from sea water.

After the end of the First World War, Haber devoted himself to the advancement of chemistry and science as a whole in Germany. He supported young investigators with original ideas and did his best to ensure that they do not leave the impoverished country.

In 1933, when Jews were dismissed from public service in Germany, Haber sent in his own resignation. Haber was born into a Jewish family but through baptism he was assimilated into the Christian community. Haber left Germany in search of new assignment. Along with his assistant Joseph Joshua Weiss (1905-1972) he moved to Cambridge, England where he stayed for few months. It has been reported that

Continued on page 27

Dipayan Dey – He chooses the less travelled path

A biotechnologist by profession, Dr Dipayan Dey practised his academic distinctions as a professor and resource person for nearly 15 years in India and abroad including University of Delhi, Chicago de Paul University (USA) and Imperial College of Science (UK). He has been a resource person and alumni to United Nations University, Tokyo Japan in the Department of Sustainable Development and a recipient of international awards and fellowships from UNEP, UNFPA, and UNO office of Food & Agriculture including the prestigious Kasumigaura Award from Japan. He is the pioneer environmentalist in India to successfully install the BIORIGHTS of commons for which he was awarded the UNEP Eco-Peace Leadership Award 2010 and IVLP Fellowship from Department of States, USA.

Presently he is leading the South Asian Forum for Environment (SAFE), a civil society organisation working towards conservation of nature and poverty alleviation through community partnership, participation and equity in the Indian eco-region. He is a Member of the National Council for Sustainable Agriculture & Climate Change and a steering committee member of National Natural Resource Management Council of NABARD in India. He was the Lead India Finalist from Kolkata, Times of India initiative and a recipient of the Idea Excellence Award in 2007.

Recently Er Anuj Sinha, Director, Vigyan Prasar and Consultant, Department of Science & Technology, Govt. of India interacted with Dr Dipayan Dey. Here are excerpts of the interaction.

Er Anuj Sinha: Thank you agreeing for this discussion despite your very tight schedule. An interview on the occasion of World Environment Day is likely to be inspiring to our readers and I am therefore grateful that you have found time. Let us commence from the time you were preparing for a research career. Please describe your academic pursuits particularly since you were training as a biotechnologist at UNU Tokyo.

Dr Dipayan Dey: It is truly an honour to interact through you with your

enlightened readers. After my masters in plant biochemistry I had the opportunity to join Sherubtse College, which is an extended campus of Delhi University in Bhutan. I did research in Bhutan on environmental biotechnology, under the aegis of a UNDP grant and was awarded PhD. The pristine Himalayan ecology gave me ample scope



Dr Dipayan Dey

to work on environmental conservation, especially that of high-altitude wetlands. The research findings were appreciated and I made my way to Japan and then to UNU after receiving the International Award on Conservation of High Altitude Lakes and Glacial Lake Outburst Flood (GLOF) from United Nations Environment Programme (UNEP), IAGLR and ILEC.

I worked with the Sustainable Development Unit of United Nations University (UNU) and International Coastal Research Institute, Iwate, Japan. While working with UNU I got in touch with 37 countries from Global South that gave me good perception of the civil society and its responsibilities. Working in science society interface taught me several lessons that are proving useful in my work today.

A.S.: When did you decide to become an activist and who was your inspiration?

DD: I never chose to be an activist – time has made me so. I was happy with my splendid life and career in Japan. From there

I shifted to De Paul University, Chicago, for advanced research. One day I had called up my parents at home saying “I have met my career goals! Are you all happy with this achievement?” They said ‘Yes, but.’ They had thought I would come back and do something at home for the common people. This set me thinking and I decided to resign my job and return to India. I started community services on the Indo-Nepal border in North Bihar and coastal areas of West Bengal.

I came to know that still there are many thousand people who cover their babies with grass and soil to keep them warm in winter nights. So much inequity and injustice was a driving force for me to work for poverty alleviation and natural resource conservation. I wanted to use my knowledge and training for these people. If this is activism then yes, I am an activist.

AS: What prompted you to enter the Lead India contest? How would you describe the experience?

DD: My journalist friends prompted me to enter this contest which I reluctantly did. While being part of it I interacted with thousands of people across the country and was able to communicate the plight of common man. This experience was unique.

Only I never liked the part that people should pay so much to vote for me through SMS and I had strictly told all not to do so. I am happy that I was eliminated in the final round. When Javed Akhtar Saheb asked me, why sufficient number of people didn't vote for you, I responded “To my people, the cost of one SMS means one meal and I have told them not to vote. I may have been eliminated from the Lead India contest, but in reality it is difficult to eliminate a leader.”

However, common people could connect to this show, and that is more important. I am grateful to The Times group and all others for the support. The touch that I got from Dr APJ Abdul Kalam during the show is what inspires me forever. He had asked me, ‘Dipayan, do you have a dream that keeps you awake at night? Have the guts to dream that dream.’

AS: The difference between the qualities and commitments of the last eight

finalists was really marginal. Have you remained in contact with the other finalists? After the competition is there cooperation among the young leaders?

DD : Definitely we are in touch. However, vision and mission changes with time and space of life. We all are in our own journeys of life and all must be doing fine.

AS : Perhaps this interview will reach some of the panel members and all the participants and help them reconnect. Are there lessons for other organisations from the way Times Foundation organised the Lead India Campaign?

DD : In our country the initial sensitisation is always very good ...and equally bad is the follow up part. We must not market an idea just by sensationalising it. One should live the idea. 'Lead India' was a great campaign, had it been continued seriously, it could have manifested into a great movement. There is a lot of mileage left in that idea.

AS : What tips would you offer to the contestants of this year?

DD : Times Foundation has withdrawn the programme despite its success. The contest doesn't exist anymore.

AS : Your work on the Kolkata Wetlands has been very impressive. The site has retained its status under Ramsar Convention. It is almost 40 years since the Convention was ratified and these wetlands identified for special attention. What were the major factors responsible for its degradation and how did South Asian Forum for Environment (SAFE) address these?

DD : The major factors behind the degradation of East Kolkata Wetlands Ramsar site was largely urban encroachment, escalating noxious pollutions and also apathy of policy makers. SAFE, set up over 13 years ago, developed a community based conservation paradigm that recognises the Biorights of wetlanders. Biorights is a financial module to compensate the opportunity cost of the poor incurred in conservation. This has empowered the inhabitants to drive away the encroachers. Community adaptability and mitigation measures taken by SAFE have been very useful in conservation. Most important was the awareness campaign about the wetlands and it had its upshot at the policy level also. People of Kolkata take pride in East Kolkata Wetlands now.

AS : Involving the local population was the key to the success of this campaign.



Dipayan interacted with the members of women's Self Help Groups

How were you able to reach this diverse group and obtain their support? Are there some lessons for other activists when designing communication strategies?

DD : It now looks very simple and elementary. We patiently listened to the problems of the people first, helped them to identify the most critical ones and then to find a feasible solution for it. We acted as a catalyst, but never pretended to be a universal solvent. The common people quickly connect to two important things, one is livelihood and the other is health and hygiene. Everywhere we start with health camps and then take up capacity building and financial inclusion for alternative livelihood. Environmental conservation comes after these. Though, at the end of the day they understand that conservation is the universal remedy.

AS : Could the awareness and communication strategies adopted, in retrospect, have been better planned? What would you like to do differently if a similar challenge excites you and SAFE decides to launch an initiative?

DD : Every community or habitat has its own character. There is no thumb rule for success. In this regard, every venture has a new type of challenge. Definitely it could have been better planned in East Kolkata Wetlands, but time was short and the challenge much bigger. In any such similar situation, I think my team would first give more space and time to know the people and their community. Then communication becomes straight and easy. We have started working in areas of West Bengal and Jharkhand where

people are economically challenged and also cornered with terrorism. We are reaching to them, listening to them, trying to address the problems jointly. We need to develop partnerships, encourage participation and assure equity and reciprocity. It has to work!

AS : This is very impressive, Dipayan. Coming back to your work site in East Kolkata, there are many tourists and other visitors to the large wetland. How are they sensitized to the importance of the site and encouraged to conserve the ecosystem?

DD : We have set up ecotourism hubs, trained the local people, and handed these over to the community. They are empowered and are taking great care of tourists and ensuring even their behaviour. The visitors can see our research station, take a boat ride with the fishermen, learn from visual displays, enjoy an aquarium to see the live endemic fishes there and so on. This encourages them to ask and know more. They also get exposed to the local culture and cuisines that develop interest in the area and its inhabitants. They also learn to be true ecotourists as they see what they are paying is directly going to the benefit of the community and the ecosystem. There are no private players in between. SAFE has recently installed a monitoring committee, with representatives from the community, women Self Help Groups (SHGs) and SAFE representatives. Our field volunteers give them all the information about the importance of the ecosystem, and guide them.

AS : The Climate Change Adaptation strategies are demanding on the poor and

South Asian Forum for Environment

South Asian Forum for Environment [SAFE] is a registered civil society organisation working towards sustainable environmental development and poverty alleviation in the Indian ecoregion of South Asia. SAFE works to achieve its development objectives through participation, partnership, equity and reciprocity and envisages global reciprocal partnership and a participatory policy frame for commons to promote sustainable environment development and wise use of natural resources. SAFE has successfully launched India's first Biorights project in East Kolkata Wetlands, the only Ramsar site of West Bengal, in year 2008.

The journey of SAFE started from Bhutan, in year 2000 while working on Glacial Lake Outburst Flood, GLOF in Eastern Himalayas. The organisation has been conferred with several awards including the United Nations Award, UNEP awards, and prestigious Kasimigara Award from Japan. Moreover the biggest award is the tremendous community support and participation in every conservation effort that has always added to the organisation's determinations.

As an important contribution to climate mitigation and adaptation, SAFE has commendably worked towards Biorights of commons and the admirable feat came about in three years, after the success of Biorights, strengthening the belief that conservation and poverty alleviation can be achieved steadily if not easily.



Dr Dipayan Dey with farmers at a wetland site in West Bengal

exempting the rich even within our society. Do you agree and if so how can the cost be shared more equitably?

DD : Yes, I agree with this but at the same time I believe that no legal remedy or policy execution can be thought of to bridge the gap. Actually, we are yet not educated enough to understand the responsibility. There can be two ways of sharing the pay load equitably. A gentle way is transforming all nature services to some financial tools for compensating the opportunity cost of the poor – and a harsh way is to levy taxes on emission or urban carbon footprints so that resource consumption can be regulated.

AS : You have made a 'trigger' film on the Kolkata Wetlands that was screened at the recent Round Table on Climate Change in Kolkata. Was this your first brush with the art and science of film making? What was your learning from this project? How has the audience reacted to the issues raised and the way these have been presented?

DD : No, this was not the first film project. Our team regularly makes in-house documentaries for school children and communities. We get tremendous positive response from our viewers. The short documentary on East Kolkata Wetlands has brought a nationwide response. Central

Inland Fisheries Research Institute (CIFRI), Barrackpore and Central Institute for Fisheries Education (CIFE), Mumbai have purchased the documentary for their training workshops. We were invited to the Annual Conferences for the Society of Wetlands Scientists International and Society for Restoration Ecology International, where we showed the documentary.

AS : Has the mainstream media during the past few years become more sensitive to issues of science in general and climate change in particular? How can we increase coverage in news, editorial and features on developmental issues?

DD : Yes the mainstream media has definitely become more sensitive to environmental issues. Increasing the coverage can have a three-fold strategy as far as my opinion is concerned:

1. For scholars and above-average readers, the economics of environment and climate issues must be reported in a smooth read-ready format;
2. For the common reader, case studies must be published with detailed contacts of the person(s), photographs and graphics; and
3. For policy and decision makers, survey spreadsheets with analysis and graphs should be published.

AS : What are the plans of SAFE in the next few months and how are you preparing your team for tackling these?

DD : We have undertaken conservation and poverty alleviation projects in Purulia, West Bengal, North Bihar and parts of Jharkhand. It is an extremely challenging field. The next campaign we are launching is of community water governance. Providing safe clean drinking water to the community in a sustained model is a challenge and requires commitment to accomplish the mission. The teams are well acquainted with the model, and are frequently visiting the project sites, interacting with the community to study the pros and cons. It is important to create a suitable platform before the commencement of the projects. The skills of my team have evolved over time and they work as leaders in the field; I just try to set them free from fear of failure.

AS : SAFE has truly embarked on very important projects under your leadership. Thanks very much for a free and frank discussion.

DD : It's my privilege. ■

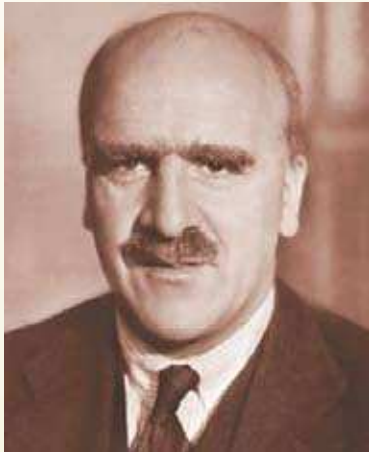
Fossils tell the tale of life on Earth

Indeed how interesting and exciting it will be today to know the size and types of organisms (plants and animals) and their ways of living on Earth millions of years ago. The study of fossils arouses an enthusiastic feeling in everyone. According to the Webster's dictionary, 'fossil' refers to the remains of animals or plants of geologic age that are naturally preserved in the Earth's crust. The word fossil is derived from the Latin word *fossus* which means 'extracted by digging'.

The geneticist and science communicator J.B.S. Halden wrote about fossils in his book titled *Everything has a History*, "Fossils are of interest for two rather distinct reasons. In the first place they tell us about animals and plants which lived in the past, what they were like and how they had evolved. Secondly, they enable us to date rocks".

Halden wrote many popular science articles on fossils to create natural interest of common man in them. These articles are highly motivating and educative. Fossil and palaeontology (fossil science) are both very interesting. Palaeontology has proved to be a useful tool in understanding the history of life on Earth. Xenophanes (570-480 B.C.) wrote about marine fossils (sea shells) and Aristotle (381-322 B.C.) believed that fossils were the remains of ancient life. The Italian artist, philosopher and scientist Leonardo Da Vinci had drawn conclusions akin to those arrived at by Aristotle. In 1027, the Persian physician and philosopher Ibn Sina wrote about fossils in his book titled *The Book of Healing*. The Chinese explorer Shen Kuo (1031-1095) studied marine fossils and explained their relationship with the geological processes. The European philosophers Konrad Jessner and Georg Agricola discussed the physical and mysterious properties of fossils. These studies indirectly led to the explanation of the origin of fossils.

In 1665, German scholar Athanasius Kircher and English natural philosopher Robert Hooke carried out the scientific analysis of petrified wood. In 1667, Danish geologist Nicolas Steno dissected the head of a shark and carried out a comparative study of shark's teeth and its fossil. He noted that the shark's teeth bore a striking resemblance to certain stony objects, found embedded within rock formations. Steno's work on shark teeth led him to propose that the body parts of dead organisms get buried under the



J. B. S. Halden



Georges Cuvier

soil and become stone-like after passage of millions of years.

The British engineer William Smith (1769-1839), observed during civil construction using stones that the stones belonged to different eras and that fossils of a particular era get preserved in them. To explain this natural process, he called it the 'principle of faunal succession'. As Smith preceded Charles Darwin, he was oblivious of the process of the evolution of species in nature.

In the theory of evolution of species propounded by Charles Darwin (1809-1882), the study of fossils had an important role. During his voyage on the *Beagle*, Darwin discovered many animal fossils from the forests of South America which impressed him. Darwin connected the ancient fossils found in different layers of rocks with the evolution of species and proved that the process of the evolution takes place on Earth



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in a continuous manner.

The contribution of the French naturalist Georges Cuvier was important in removing the confusion from the minds of scientists about the nature and existence of fossils. In the eighteenth century, Cuvier gave a scientific explanation of the reasons behind the extinction of animals. This, in true sense, laid the foundation of the palaeontology. Under this new branch of study, rapid research thereafter started on fossils discovered from different sites around the world.

In 1796, Cuvier gave his maiden lecture on palaeontology that was later published in the form of a research paper in 1800. In this paper he analysed skeletal remains of Indian and African elephants as well as mammoth fossils, and established for the first time that African and Indian elephants were different species and that mammoths were a different and extinct species. Also in 1796, Cuvier published a research paper focussing on a comparative study of palaeontology and extinction of animals. This initiated discussions on palaeontology and animal extinctions within the scientific community.

Prior to the publication of Cuvier's paper, the worldview was that no species on Earth ever undergoes extinction. During the decade beginning 1770, French naturalist Georges Buffon claimed that fossils of the rhinoceros and mammoth were found in Europe whereas these animals lived in the tropical regions. Cuvier contradicted this fact and said that many species of animals suffered extinction due to various catastrophes hitting the Earth including the Ice Ages. Cuvier carried out deep research on the fossils of reptiles, molluscs, fishes and mammals. He held that almost all the species the fossils of which were discovered had already suffered extinction.

From the detailed study of fossils, palaeontologists towards the end of the twentieth century came to the conclusion that the history of life on Earth is at least 3.5 billion years old. As new discoveries were made in this direction, the riddle of the history of life on Earth and its evolution started unfolding. The study of fossils has proved extremely helpful in understanding the evolution of species.

In palaeontology, only those remains of a species are called 'fossils' that are at least 10,000 years old. These fossils may be those of organisms as minute as unicellular organisms (with diameter of one micrometre) and may be as gigantic as dinosaurs having a length of several metres and weighing several tonnes. The oldest fossil forms found on Earth are the stromatolites. These are layered fossils made up of layers of cyanobacteria. Stromatolites are estimated to be 3.4 million years old. The study of fossils, in the present day context, makes use of many branches of science, e.g., mathematics, engineering, physics, biochemistry, etc.

In reality, a fossil refers to the remains of some animal or plant buried in Earth millions of years ago. Fossils may be in the form of the body parts of animals, their bones, or the pathway or tunnel used by them. Fossils have a fascinating world of their own. Some fossils are so minute that they are invisible to the naked eyes. They are called microfossils. At times, the geophysical processes lead to the formation of fossil-like patterns of salt in rocks. They are regarded by mistake as real fossils although in their formation and development no biological process is involved. Such fossils are called pseudofossils. Sometimes, round or egg-shaped patterns are naturally formed between the layers of sedimentary rocks. Often, these are mistaken as dinosaur's eggs.

If the entire body of dead plant or animal is consumed by scavengers and bacteria-like microorganisms then no fossil formation can ever take place in nature. Actually, what happens is that many a time these scavengers and microorganisms are not able to fully decompose the bodies of dead organisms and, therefore, some of their parts like hands, legs, head etc. are left in the soil. Sometime, mud, soil or dust gathers over them. Over time the tender portions of the body parts of plants or animals are decomposed by the bacteria. Minerals fill the cellular spaces and crystallise. The shape

of the original plant or animal is preserved as rock. Sometimes the original material is dissolved away leaving the form and structure but none of the organic material remains. Sometimes, hard parts like shells, bones or wood do not get decomposed. Here



Petrified wood

also, minerals present around these parts get deposited on them which after millions of years are transformed into stones.

Such fossils found in nature are called petrified fossils. The fossils of the bones of dinosaurs and wood of trees have been discovered from many parts of the world. An entire fossil tree has been beautifully left preserved in the Petrified Forest National Park situated in Arizona, U.S.A. Sometimes, imprints of a tree leaf or the body of a spider, ant or fish are found in stones in the form of fossils.

Another important form of fossils is known as amber fossil. Ambers are resins which have turned hard. Resin is a kind of liquid exuded from some trees. Turpentine oil is made from the resin found in pine



Insect trapped in amber

trees. When the trees get hurt, they start discharging resin as a sticky liquid. Due to its stickiness, innumerable insects, spiders, etc., get stuck and are thus trapped into it. The chemicals present in the resin act to preserve the insects and so their remains are left intact for hundreds or thousands of years. With passage of time, the resin hardens and turns into amber, and the bodies of the insects stuck and trapped in it are left intact. Palaeontologists of today have discovered insects that got trapped in the resin of plants millions of years ago; and thus they have been able to gather information about the insects of ancient times.

Fossils are also found buried in ice. The fossils of a species of ancient elephants called mammoths have been discovered from the snow-clad hills of Alaska and Siberia. These frozen fossils were used by Eskimos as feed for their dogs. Once upon a time, half the supply of ivory the world over was met by the huge fossils of mammoths. Scientists are now studying the blood vessels, muscles, hairs, skin and other body parts obtained from the fossils of mammoths by preserving them. Some of the fossils of mammoths are also kept in the museums.

The footprints of ancient animals also come under the class of fossils. In the past, the footprints of spiders, birds, four-legged animals or dinosaurs might have been left on wet mud or sand. Some of these footprints have been kept intact by nature. The mud or sand in course of time got converted into stone but the footprints encapsulated in them have remained intact.

Dinosaurs called Protoceratops had body lengths ranging from 1.5-2.0 metres used to lay their eggs in the sand akin to the manner done by tortoises and turtles of today. Scientists have been able to discover fossils of the eggs of these dinosaurs that are about 75 million years old. When palaeontologists broke open some of these petrified eggs, they were astonished to see petrified bones of baby dinosaurs inside.

Searching for fossils is a difficult and laborious job indeed. Most fossils are found in sedimentary rocks and river beds. Laws have been passed by the governments of many countries for proper excavation of rare fossils of dinosaurs and other organisms. These laws allow only proficient scientists to execute this job because they are well conversant with the fossils and the scientific ways of their excavation.



Fossils of a mammoth (left) and the imaginary picture of a group of mammoths in past (right).

Dinosaur fossils have always been the centre of public attraction in museums around the world. These reptiles roamed the Earth for million years in the Mesozoic era. A catastrophic event some 65 million years ago wiped out these giants from the face of the Earth. The word 'dinosaurs' was coined by the British palaeontologist Richard Owen in the year 1842. This word has been derived from the Greek word *deinosauros* which means 'terrible lizards'.

Fossils of dinosaurs have been unearthed from many places around the world including many sites in India. Dinosaur fossils have been found from Maharashtra (Nagpur), Gujrat (Khera, Panchmahal, Kutch), Andhra Pradesh (Ajilabad), Madhya Pradesh (Bagh, Jabalpur), Tamilnadu (Tiruchirappalli) and Meghalaya (near Shillong). The Indian scientist Birbal Sahni worked lifelong on plant fossils. In 1949, he laid the foundation of the Institute of Palaeobotany in Lucknow, Uttar Pradesh which is now known as Birbal Sahni Institute of Palaeobotany. For research on plant fossils, this Institute is regarded as the sole Institute not only of India but of the world at large.

Palaeontologists have so far been able



Birbal Sahni

to find about 500 genera and more than 1,000 species of dinosaurs. Their fossils have been found from every continent of Earth. The analysis of these fossils has brought home the fact that some dinosaurs were vegetarian while others were flesh-eaters. Some dinosaurs were of giant size while others were of human size or even smaller. Most of the dinosaurs made nests in which they laid their eggs. This behaviour of dinosaurs resembles modern birds. The study of the fossils of dinosaurs has revealed that in the Jurassic Age, the evolution of birds took

place from dinosaurs.

If we look back to history, our modern life is virtually running on the fossils of the organisms (animals and plants) that lived on Earth long ago. Almost all the fuel we use today – coal, petrol, diesel, and gas – are all fossil fuels. They are actually formed from the fossils of plants and animals that existed on Earth millions of years ago. There would be no motor cars, trains, buses, aeroplanes, ships, or industries without these fuels.

An important building material such as limestone is actually made up of fossilised skeletal fragments of marine organisms such as coral. Even chalk, which is used in schools and colleges for writing on blackboards, is a kind of fossil.

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The skull of a Protoceratops (left) and its fossilized eggs (right).

(Translated by: Abhash Mukherjee) ■

Sound and Fury

Winning the Decibel War

"In antiquity there was only silence. With the invention of the machine, noise was born. Today, noise triumphs and reigns supreme over the sensibility of men."

— Luigi Russolo in *The Art of Noise*



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With streets chocked with shrieking motorbikes, scooters, three-wheelers, buses, cars, *phatphatias*, and trucks, skies taken over by aeroplanes zooming over our heads, *desi* and foreign recreational systems screaming at their loudest, loudspeakers blaring from *pandals* and rooftops — and only a muted civil code in place to regulate the din — there is no respite for our poor ears, body and mind. Drummed day in and day out by loud unwanted unpleasant sounds, the indignities heaped on us must take their toll.

Studies indicate that most city-dwellers in Indian cities are suffering the ill effects of this terrible din. While the mind and body must pay the price, the biggest victim is the hearing gear. Those who live in noisy environments must suffer a gradual but growing loss of hearing. Since the loss is spread over a long period of time, it is often not noticeable until it becomes considerable. The truth of the matter



is when Mother Nature carved out our brilliant hearing apparatus that is capable of receiving the softest of whispers she could not have imagined the miseries that man would invent for it.

The safe limit

Not that Mother Nature did not keep safety margins; she had given man considerable allowance, but man was careless enough to surpass the limits.

Defining noise pollution, however, is not easy. Part of the difficulty lies in the fact that in some ways it is different from other forms of pollution. For one, noise is transient; once the pollution stops, the environment is free of it. This is not the case for chemicals, sewage, and other pollutants introduced into the air, soil, or water. Two, while other forms of pollution can be measured, and scientists can estimate how much material can be introduced into the environment before harm is done; this is simply not possible in the case of noise pollution. Though we can measure individual sounds that may actually damage human hearing, it is difficult to monitor cumulative exposure to noise or to determine just how much is too much.

Then again, the definition of noise itself is highly subjective. To some people the roar of an engine is satisfying or thrilling; to others it is an annoyance. Loud music may be enjoyable or a torment, depending on the listener and the circumstances.

Broadly speaking, any form of unwelcome sound is noise pollution, whether it is the roar of a jet plane overhead or the sound of a barking dog a block away. One measure of pollution is the danger it poses to health. Noise causes stress, and stress is a leading cause of illness. Therefore any form of noise can be considered pollution if it causes annoyance, sleeplessness, fright, or any other stress reaction.

The actual loudness of a sound is only one component of the effect it has on human beings. Other factors that have to be considered are the time and place, the duration, the source of the sound, and whether the listener has any control over it. Most people would not be bothered by the sound of a 21-gun salute on a special occasion. On the other hand, the thump-thump of a neighbour's music at 2 a.m., even if barely audible, could be a major source of stress.

Measure of sound intensity

The decibel (dB) is a measure of sound intensity; that is, the magnitude of the fluctuations in air pressure caused by sound waves. The decibel scale is logarithmic, not arithmetic. This means that a doubling of sound intensity is not represented as a doubling of the decibel level. In fact, an increase of just 3 dB means twice as much sound, and an increase of 10 dB means ten times as much sound.

A sound pressure level of 0 dB represents the threshold of hearing in the most sensitive frequency range of a young, healthy ear, while the thresholds of tickling or painful sensations in the ear occur at about 120 dB (which is about 10^{12} times greater than zero decibel).

Decibels are usually measured with a filter that emphasises sounds in certain frequencies. The "A" filter (dBA) is the one most frequently used. The "C" filter (dBC) puts more weight on low-

frequency sounds such as the bass in amplified music.

The perception of loudness by the human ear is not directly proportional to the decibel level. For example, a sound 10 dB greater than another is not perceived as being ten times as loud but only about three times as loud.

The intensity of noise diminishes with distance. Outdoors, and in absence of any close reflecting surface, the effective decibel level diminishes at a rate of 6 dB for each factor of two increase in distance. For example, a sound measuring 100 dB at 10 metres would be 94 dB at 20 metres, 88 dB at 40 metres, and so on.

Sound level meter

A sound level meter is a device for measuring the intensity of noise, music, and other sounds. A typical meter consists of a microphone for picking up the sound and converting it into an electrical signal, followed by electronic circuitry for operating on this signal so that



the desired characteristics can be measured. The indicating device is usually a meter calibrated to read the sound level in decibels (db).

In the early 1970s, as concern about noise pollution increased, accurate, versatile, portable noise-measuring instruments were developed. The electronic circuitry can be adjusted, usually by an external switch, to register the integrated level of all frequencies in the sound being measured or the intensity of selected bands of frequencies. A time lag is usually incorporated to slow down meter response and thus permit rapidly varying sounds to be averaged. The amount of time lag may vary somewhat among instruments, depending on the purpose for which the instrument was designed.

With the help of sound-level meters, it has been determined that whispering produces a sound level of 20 to 30 decibels; normal conversation, 60 to 65 decibels; rustling of leaves, 45 decibels; average radio and vacuum cleaner, 75 decibels; tractor, farm equipment and power saw, 100 decibels; outboard motor, chain saw and jack-hammer, 120 decibels; jet takeoff and amplified music, 135 decibels; and gunshot and siren at 30 metres, 140 decibels.

The danger zone

Since permanent hearing loss is usually a long-term process, it is impossible to know at exactly what point noise becomes loud enough to cause damage to the ears.

The U.S. Environmental Protection Agency has established 70 dBA as a safe average for a 24-hour day. This figure is based only on the risk to hearing, and does not take into account other health factors such as loss of sleep. Since sound intensity doubles with every increase of 3 dB, the time of safe exposure would be cut in half with each such increase. Thus a worker should wear ear protection if exposed to a steady 75 dBA for eight hours, 78 dBA for four hours, and so on. Brief exposure to noises of up to 100 dBA is not considered risky provided the average remains within the prescribed levels.

Actual limits for workers tend to be more permissive. In most jurisdictions, the permissible limits for the workers are exposures of up to 85 or even 90 dBA for eight hours. Using the higher of these figures, the sound level in a typical nightclub, 110 dBA, could pose a risk of permanent hearing damage after as little as four minutes of exposure. Of course, noise is dangerous in other ways too. It leads to productivity losses due to poor concentration, communication difficulties or fatigue due to insufficient rest. It produces loss of psychological well-being and can be a cause of stress, illness, suicide, aggression, and violence. It increases the health care costs due to the loss of sleep, hearing problems or stress.

Effects of noise

Studies conducted under the aegis of WHO and other health bodies and societies suggest that noise can affect human health and well being in a number of ways. The ill effects have many dimensions — physiological, psychological and physical, including the loss of hearing acuity.

Physiological changes in the body

The body undergoes a number of temporary physiological changes when the noise surpasses the permissible limits. The sweat glands become more active, the breathing rate goes up, the heart rate increases, the blood pressure rises, and the intra-cranial pressure goes up.

High decibel noise also interferes with sleep. It also causes narrowing of the pupil of the eyes with diminution in colour perception and night vision. People, who swing to high decibel music at late-night parties and then drive home, should make a note of this.

Mind takes a tumble

Noise affects mental concentration, causes interference with communication, impairs efficiency, makes people lose their cool and affects social behaviour. It can trigger annoyance and frustration as a result of interference, interruption and distraction. Activity



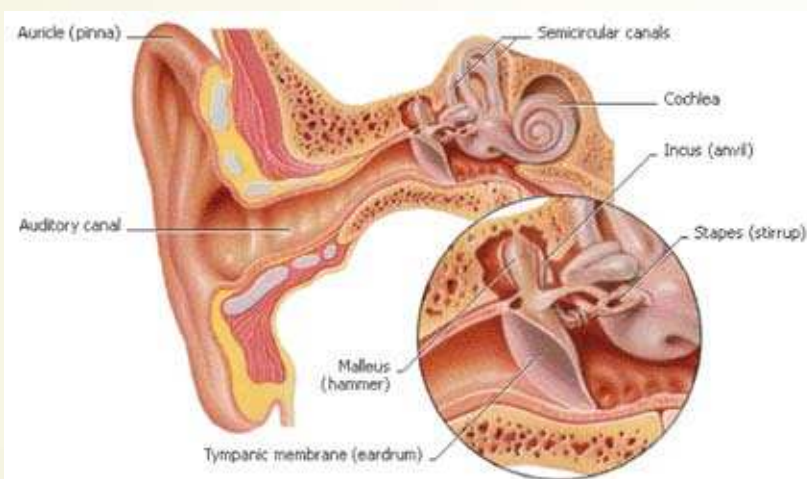
disturbance is regarded as an important indicator of the community impact of noise.

Noise-induced stress can create severe tension in daily living and may contribute to psychological illness. This is reason enough to make your workplace and streets friendlier in terms of sound levels.

Physical ill effects

Exposure to noise is also associated with a range of possible physical effects including: colds, changes in blood pressure, other cardiovascular changes, gastro-intestinal disorders and general fatigue. Excessive noise can also affect the digestive system and may precipitate heartburn, indigestion, and ulcers. It may also produce giddiness and nausea.

The ears can go deaf. A victim can experience an upward shift in his hearing threshold and ringing and buzzing in the ears. Should these warning signals be ignored, the hearing sensitivity begins to decline. Consistent evidence exists that prolonged exposure to



Structure of the Ear: The human ear consists of three sections: the outer ear, the middle ear, and the inner ear. The outer ear includes the auricle (pinna), the visible part of the ear that is attached to the side of the head, and the waxy, dirt-trapping auditory canal. The tympanic membrane (eardrum) separates the external ear from the middle ear, an air-filled cavity. Bridging this cavity are three small bones — the malleus (hammer), the incus (anvil), and the stapes (stirrup). The cochlea and semicircular canals make up the inner ear.

As a responsible member of the civil society, take steps to ensure that the municipal authorities take adequate steps to check the noise from homes and religious places, street traffic, rail traffic and aircrafts.

Let me hope you are listening!

noise levels at or above 80 dBA can cause deafness. The amount of deafness depends upon the degree of exposure. Repeated or continuous exposure to a noise level of 80 decibels or more delivers a knockout to the organ of Corti based in the internal ear.

Stop the noise racket

Should you wish to make a change, stop the noise racket. Begin now! Replace the silence in the motorbike, unplug the pressure horn in your car, tone down the television set, disconnect the loud speaker, and despite decibel advances in music systems, tone down the volume.

Continued from page 36 (Fritz Haber: The discoverer of the synthesis of ammonia from its elements)

at Cambridge Ernest Rutherford pointedly refused to shake hands with Haber for his association with gas warfare. Chaim Weizmann (1879-1952) had offered Haber the position of director at the Sieff Research Institute (which was later renamed as Weizmann Institute) in Rehovot. Haber accepted the offer but he did not live to join it. He died on 29 January 1934 in a hotel in Basel, where he was resting on his way to Rehovot.

After Haber's death Kaiser Wilhelm Institute was renamed as Fritz Haber Institute. This was made possible because of the initiative taken by the German physicist Max Theodor Felix von Laue.

BBC Radio 4 Afternoon Play produced and broadcast two plays on the life and work of Haber. The first play titled "Bread from the Air, Gold from the Sea" was first broadcast on 16 February 2001. The second play was titled "The Greater Good"; it was first broadcast on 23 October

2008. In 2003, Vern Thiessen produced a play giving a fictional description of Haber's life, especially highlighting his long-time relationship with Albert Einstein. Thiessen's description of Haber was a tragic figure who tried unsuccessfully throughout his life to evade both his Jewish ancestry and the moral implication of his scientific research directed to chemical warfare. In 2008, a short film entitled "Haber", written and directed by Daniel Ragussis, depicted Haber's decision to embark on his research on gas warfare and his relationship with his wife.

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(The article is a popular presentation of the important points of the life and work of Fritz Haber available in the literature. The idea is to inspire the younger generation to know more about Haber. The author has given the sources consulted for writing this article. However, the sources on the Internet are numerous and have not been individually listed. The author is grateful to all those authors whose works have contributed to writing this article and the sources of the pictures reproduced here.)

Recent developments in science and technology

A genetic route to malaria control

Malaria is a major killer disease in many countries including India. The parasitic disease is present in 90 countries and infects one in 10 of the world's population. According to the World Health Organisation, there were 25 million cases of malaria in India in 2009, which was one-tenth of the total malaria cases in the world. In same year more than 30,000 people died of malaria in India.

Although drug therapy using drugs like chloroquine and artemisinin combinations have been used to treat malaria, there are reports of the malaria parasite developing resistance against these drugs. A better way of controlling malaria would be to prevent the spread of the parasite that causes the disease. The malaria parasite *Plasmodium* is transmitted by the anopheles mosquito, which breeds in stagnant water. If the breeding of the anopheles mosquito could be prevented so can be the spread of the parasite. However, in cities where stagnant water is found almost everywhere – in room coolers, flower pots, discarded containers, overhead tanks, and roadside ditches – controlling mosquito breeding is an uphill task. Now an international team of researchers has come up with a better alternative – genetically manipulating large populations of mosquitoes that could eventually dramatically reduce the spread of the deadly disease.

Researchers from Imperial College, London and the University of Washington, Seattle, USA have found that after making specific genetic changes to a few mosquitoes and then allowing them to breed on, genetic alterations could be spread through large mosquito populations in a few generations and the method may in future be used to spread genetic changes in wild mosquito populations to make them less able to transmit malaria (*Nature*, 21 April 2011| doi:10.1038/nature09937). They said this

is the first successful proof-of-principle experiment of its kind. The research was led by Andrea Crisanti of the life sciences department of Imperial College, London.

The researchers showed that a modified genetic element of the mosquito – an endonuclease gene called *I-SceI* – can efficiently spread through caged populations of mosquitoes. Endonuclease is an enzyme that cuts nucleic acids in the DNA and



Anopheles mosquito that spreads malaria

produces fragments of various sizes. The researchers found that the *I-SceI* gene 'homes' in to a particular portion of the DNA where it becomes integrated into the broken chromosome. According to Crisanti, this process – known as 'genetic drive' – could be used to transmit a genetic change through a population of mosquitoes that affects the insects' ability to carry malaria.

Crisanti's team bred mosquitoes with a green fluorescent gene as a marker that can easily be spotted in experiments. They allowed these insects to mate with a small number of mosquitoes that carried a segment of DNA coding for an enzyme that can permanently inactivate the fluorescent gene. They expected that transfer of the DNA segment would lead to inactivation of the fluorescent gene in the new offspring. After each generation, they counted how many still had a gene for green fluorescence. The results showed that after starting with almost 99 percent of fluorescent mosquitoes, more



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than half had lost their green genes in just 12 generations, which meant that the DNA segment was being effectively transmitted to subsequent generations. According to the researchers, this technique should allow scientists to focus on controlling just the most dangerous mosquito species, without affecting even very closely related mosquito species, leading to a uniquely safe biological control measure.

The team is now working on targeting genes that the mosquito needs for reproduction or malaria transmission. They hope, with the new technology, the release of a few genetically modified mosquitoes could eventually cause a dramatic reduction in malaria-carrying mosquitoes in countries where the disease is endemic.

Drugs boost antibiotic function

Antibiotic resistance is a growing concern today, with pathogenic bacteria developing resistance to even some of the most powerful modern antibiotics. The scare about the spread of bacteria carrying the NDM 1 gene and MRSA (Methicillin-resistant *Staphylococcus aureus*) bacteria are recent examples.

Antibiotic resistance in bacteria develops mainly due to indiscriminate and improper use of antibiotics. A complete course of antibiotics is needed to kill all of the harmful bacteria. When the complete course of an antibiotic is not taken by a patient, all the pathogenic bacteria are not killed and the surviving bacteria gradually develop resistance against that antibiotic. Bacteria develop resistance in several different ways, all of which involve changes in their genetic material, or genes. These altered genes enable the bacteria to either



Antibacterial activity of antibiotics can be improved by combining with bioactive drug compounds.

destroy the antibiotic or otherwise block its ability to inhibit bacterial growth. Over the decades, bacteria have continued to become resistant to antibiotics, despite the introduction of new and stronger medicines. A recent study shows that if antibiotics are combined with bioactive drug compounds their antibacterial activity can be improved, breathing new life into antibiotics weakened by growing bacterial resistance.

For decades, researchers and clinicians have been using combinations of antibiotics to broaden antimicrobial spectrum and generate synergistic effects, but it did not work always. Now a team of researchers from the UK and Canada led by Gerry Wright, an antibiotic biochemist at McMaster University, Ontario, Canada, have tried out combinations of non-antibiotic drugs with antibiotics to explore their clinical efficacy in treating infections with bacteria resistant to common antibiotics, with encouraging results. The scientists screened minocycline – a broad spectrum tetracycline antibiotic – in combination with more than 1,000 previously approved bioactive drug compounds – most of which had no known antibiotic function – against three common and often resistant bacteria: *Pseudomonas aeruginosa*, *Escherichia coli*, and *Staphylococcus aureus*. They found a total of 69 compounds never before used to treat bacterial infections that, when combined with minocycline, reduced bacterial growth by at least 45 percent. According to the researchers it was significantly more than when treated with the antibiotic alone (*Nature Chemical Biology*, 24 April 2011 | doi:10.1038/nchembio.559, 2011).

A significant finding of the study

was that many of the combinations inhibited only one of the three bacteria species tested, suggesting that these could be used to target specific infectious bacteria and leave the rest of a patient's microbial flora alone.

The researchers further examined loperamide, an opioid anti-diarrhoeal drug, which had no antibacterial function on its own. But when combined with minocycline it inhibited 99 percent of *P. aeruginosa* and 70 percent of *E. coli*

growth. The combination was found to disrupt the electron potential across bacterial membranes, effectively weakening the cell and giving the minocycline a way in.

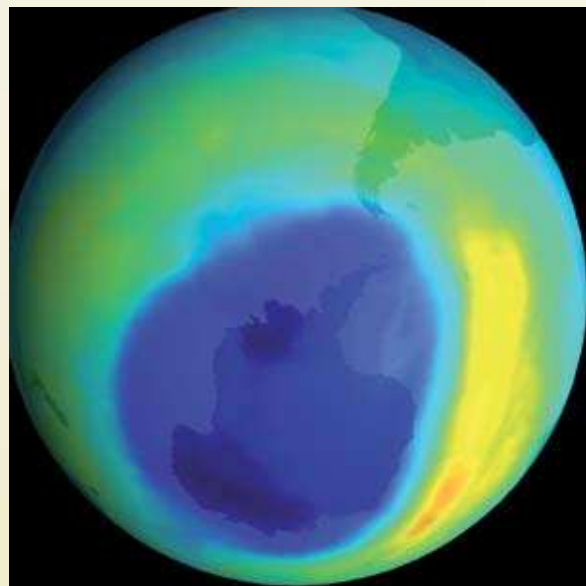
As of now the researchers are not sure how well the drug combinations will be absorbed by the human body. But they are optimistic that finding new uses for old drugs can expand the arsenal for fighting resistant bacteria. According to Wright, the work will make people realise that it is not hopeless and that we will find new ways to solve the resistance problem and the lack of new antibiotics problem.

Ozone hole linked to climate change

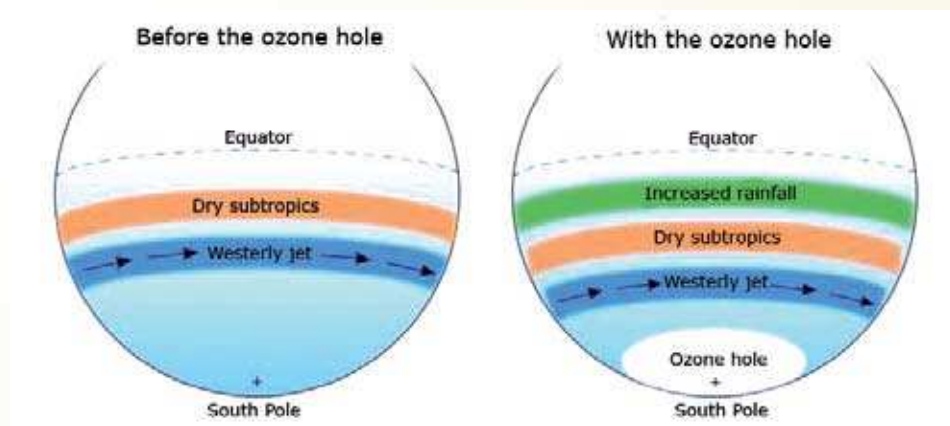
Global warming and climate change has till now been believed to be entirely due to rise in the level of greenhouse gases in Earth's atmosphere. The fourth report of the Intergovernmental Panel on Climate Change (IPCC) in 2007 stated *inter alia*, "Most of the observed increase in globally averaged temperatures since the mid-20th century is very likely (>90%) due to the observed increase in anthropogenic (human) greenhouse gas concentrations." But a recent study has brought into focus yet another factor – depletion of the ozone layer over Antarctica, commonly known as the 'ozone hole.' The study by researchers S. M. Kang and L. M. Polvani of Columbia University's School of Engineering and Applied Science, working together with

colleagues at Canada's Centre for Climate Modelling and Analysis, has shown that the ozone hole has affected the entire circulation of the Southern Hemisphere all the way to the equator. (*Science*, 21 April 2011). This is the first time that ozone depletion has been linked to climate change from the Pole to the equator. The ozone hole is now widely believed to have been the dominant agent of atmospheric circulation changes in the Southern Hemisphere in the last half century. In the study the impact of the ozone hole on rainfall was found to be significant.

Located in the Earth's stratosphere, just above the troposphere (which begins at Earth's surface), the ozone layer absorbs most of the Sun's harmful ultraviolet rays. Over the last half-century, widespread use of man-made compounds, especially household and commercial aerosols containing chlorofluorocarbons (CFCs), has significantly and rapidly broken down the ozone layer, to a point where a hole in the Antarctic ozone layer was discovered in the mid 1980s. Since the ozone layer protects life on Earth from the harmful UV radiation from the Sun, the discovery led to immediate global action. The culprits, ozone-destroying CFCs were quickly identified and action taken to ban their use and control their emissions. Thanks to the 1989 Montreal Protocol, signed by 196 countries, global production of CFC has been phased out. As a result, scientists have observed over the past decade that ozone depletion has largely halted and they now expect it to fully reverse,



Ozone hole (purple) over Antarctica



The ozone hole has affected the entire circulation of the Southern Hemisphere all the way to the equator.

and full recovery of the ozone layer by mid-century.

After the ozone hole was discovered scientists have noticed patterns of wind circulation around Antarctica changing as the ozone hole grew. But till now the role of the ozone hole – especially that of the larger one over Antarctica – in Earth's climate system as a whole was not understood well. Now the new study shows that the effects of the ozone hole extend much further than just the icy wastes of the southernmost continent.

To arrive at their inference the researchers used two different state-of-the-art climate models to show effect of the ozone hole. They first calculated the atmospheric changes in the models produced by creating an ozone hole. They then compared these changes with the ones that have been observed in the last few decades: the close agreement between the models and the observations shows that ozone has likely been responsible for the observed climatic changes in Southern Hemisphere.

Why mangroves should be conserved

Forests have been known to be large storehouses of carbon. They absorb carbon in the form of carbon dioxide and give off life-giving oxygen. That is why forest conservation is important for fighting global warming. New research has shown that coastal mangrove forests store more carbon than almost any other forest on Earth. A study conducted by a team of U.S. Forest Service and

university scientists has shown that for every hectare, mangrove forests store up to four times more carbon than most other tropical forests around the world. To estimate the abundance of carbon in mangroves, lead investigator J. Boone Kauffman, an ecologist at the Northern Research Station of the US Forest Service in Durham, New Hampshire, USA, and his team sampled 25 mangrove sites across a broad territory that included Micronesia, Indonesia and Bangladesh. This area spans 30 degrees of latitude and 73 degrees of longitude and represents about 40% of the global area covered by mangroves (*Nature Geoscience*, 3 April 2011 | doi:10.1038/ngeo1123).

Mangroves grow in tropical climate and almost 75% of world's mangroves are found in tropical coastal line between 25°N

and 25°S latitudes. This ecosystem develops well in areas where water temperature varies between 21°C and 27°C. India has some of the best mangroves in the world. These are located in the alluvial deltas of rivers such as the Ganga, the Mahanadi, the Godavari, the Krishna and the Cauveri as well as on the Andaman and Nicobar group of islands. The Sundarbans of West Bengal represent the largest stretch of mangroves in the country.

According to the researchers, the mangrove forest's ability to store such large amounts of carbon can be attributed, in part, to the deep organic-rich soils in which it thrives. They found that these forests hold much more carbon than do boreal, temperate or tropical upland forests – especially in an organic-rich 'muck layer' of soil more than 30 centimetres below the surface. The team found that this underground layer is thicker in mangrove forests in estuaries than in those near the ocean. Estuarine mangroves were found to account for more than 70% of total carbon stored while oceanic zone mangroves stored upwards of 50% of the carbon stored.

Carbon stored in mangrove sediments was on average five times larger than those typically observed in temperate, boreal and tropical terrestrial forests, on a per-unit-area basis. The mangrove forest's complex root systems, which anchor the plants into underwater sediment, slow down incoming tidal waters and allow organic and inorganic material to settle into the sediment surface. Since there is little oxygen available, decay rates slow down, resulting in much of the carbon accumulating in the soil. According to the researchers, mangroves have more carbon in their soil alone than most tropical forests have in all their biomass and soil combined.

This high-carbon storage points to the fact that mangroves may play an important role in climate change management. The area of mangrove forests around the world has shrunk by as much as 50% over the past half century because of development, over-harvesting and aquaculture. So it may be necessary to have a thorough assessment of their carbon reserves for planning future strategies to reduce climate change. ■



Carbon stored in mangrove sediments is on average five times larger than those typically observed in temperate and tropical terrestrial forests.

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:

“Should broadcast of astrological forecasts, which are utterly unscientific and misleading and contrary to scientific temper, be allowed on TV channels?”

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* June 2011” should be clearly written on the envelope.



Vigyan Prasar

A-50, Institutional Area, Sector-62, Noida 201 307 (U.P.)

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Email: info@vigyanprasar.gov.in Website: www.vigyanprasar.gov.in

Winners of “Your Opinion” contest for March 2011

Topic: “Will a complete ban on plastic carry bags and sachets help prevent pollution of the environment?”

Debkumar Bhadra

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Banning plastic carry bags and sachets is not going to work since plastics will still be used in the form of PET bottles, jars, cans, disposable plastic cups/glasses/plates, sacs, packets, tetra packs, etc. Then there are toys, utensils, furniture items, cabinets, computer/automobile parts, CDs, electronic circuit boards, the list is endless. All these plastics will be ultimately discarded in the environment causing pollution. A 2005 study by NEERI after floods in Mumbai found plastics to constitute hardly 5% of municipal waste. The component of used plastic bags was hardly 1%. Therefore singling out plastic carry bags as the sole culprit responsible for environmental pollution and imposing ban on it is unjustified.

The workable solution would be to ensure proper and continuous, collection, segregation, and management of plastic waste. Implementation of Municipal Solid Waste (Management and Handling) Rules 2000 needs to be ensured. Involvement of NGOs and civil society is also necessary. The general public should be made aware of adverse effects of plastics through mass media. Simultaneously civic bodies should promote two-bin culture for non-biodegradable and degradable wastes. Recycling plastic needs to be promoted by giving incentives, by allotting land at concessional rates, subsidising purchase of state of art recycling equipments and transport subsidy for sending plastics for recycling. Such positive steps will not only help in dealing with the problem effectively but also conserve natural resources and generate employment opportunities. In the modern world, where natural resources are dwindling, plastics, owing to their versatility find use in almost every walk of life. Under such circumstances, we just cannot avoid plastics, but at the same time we need to use the wonder material judiciously so that environmental concerns are taken care of.



Ravinder Kaur

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If the ban on plastic carry bags and sachets is implemented effectively at mass level, definitely there will be a fall in the rising pollution trend. Plastic bags are non-biodegradable and keep on accumulating on land, forming endless garbage dumps. If burnt, harmful gases like carbon dioxide, carbon monoxide, nitrogen oxide are produced which contribute to global warming and cause air pollution. The accumulated plastic waste, when consumed by stray animals, often kills them. The need is to use substitutes, which may not be at par with plastic bags in durability and convenience but would be more eco-friendly. It should be realised that if man slaps nature, nature gives a blow in return.



Dr. Lata I Shukla (BOYSCAST Fellow)

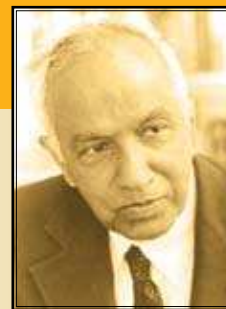
Senior Scientific Officer,
Uttarakhand Council for Science and Technology,
33, Vasant Vihar Phase II,
Dehradun, Uttarakhand

A complete ban on plastic carry bags and sachets would help prevent pollution of environment. Plastic carry bags contribute to clogged drains, clogged sewage system, and dirty landscape in open areas where they lie scattered. Plastic carry bags are also the preferred material for the disposal of kitchen waste and other materials from homes, offices and shops. There are umpteen number of cases where the alimentary canal of stray cows have been found to be choked with plastic carry bags. A complete ban is the only solution where the people would be forced to think for an alternative. Such a ban would help prevent environmental pollution.



Inspiring Chandrasekhar

Vigyan Prasar: Lecture Demonstration



Expression of Interest

Prof Subrahmanyan Chandrasekhar, a well-known Indian born astrophysicist and Noble Prize winner (1983) has always remained a great source of inspiration for students of science across the world. Vigyan Prasar in collaboration with Centre for Advancement of Public Understanding of Science and Technology (CAPUST) New Delhi is taking up a nationwide celebration of birth centenary of Professor Subrahmanyan Chandrasekhar. The celebration will continue till October 2012. The celebration will witness a series of interesting activities with a focus on high school and college students across the country. An eminent panel of talented speakers has been prepared and interaction can be arranged between the scientists and students.

The expenses incurred for inviting the speaker will be borne by Vigyan Prasar. The limited sets of motivational material in the form of badges with Prof S Chandrasekhar's photo, brochures, booklets etc. will be provided to the participants. Competent organizations interested in arranging such lectures will have to take care of local logistics for organizing the lectures at their respective places. This will include (i) Local hospitality (Local travel, Lodging & boarding) for the guest speaker (ii) Publicity in the surrounding towns and villages for a public lecture and in academic institutions for interaction with students (iii) Providing computer with power backup, screen, LCD projector and public address system, etc. inside the auditorium (iv) Administer a structured feedback to the participants and (v) Provide two or more photographs of the event and a brief report that will include copies of press clippings from local/regional/ national news papers of the event.

Interested organizations/institutions including university departments, post graduate colleges, high schools and registered NGOs engaged in science education/popularization of science are requested to submit their expression of interest in the prescribed format given below on or before 31 July 2011.

Application Format

Name of the Organization/ College/ Institution/School:

City: Office Number: e-mail:

Name & mobile number of head of the institution/NGO

Name/Mobile number of coordinator: Website:

A. Name of the nearest Airport/ Railway station and distance from institute.

Airport: Railway Station:

B. We would like to organize

1. Public lecture

2. College Lecture-Demonstration

3. School lecture

C. Please specify the dates according to the preference till October 2012

First preference	Second preference	Third preference

We understand the terms of this offer and agree to meet obligations of the host organization in view of our commitment to create excitement for science amount young generation.

Date:

Signature

Place:

Stamp.

Send to:

Dr Arvind C. Ranade, Scientist-D

Vigyan Prasar, A-50 Institutional Area, Sector 62, NOIDA UP: 201 309

e-mail: arvind.c.ranade@gmail.com

Phone: (0120) 2401723, 2404430 Ext 208

Fax: (0120) 2404437

Message from the editor

You are one of our valued subscribers of *Dream 2047*. You might be aware that Vigyan Prasar is bringing out this magazine for last thirteen years. Present circulation of the magazine is fifty thousand. Although we are constantly receiving new subscription requests, it may not be possible for us to increase the print run any further.

Recently we have commenced bringing an electronic version of the magazine. Every month we are sending the e-version to several thousand subscribers through emails. The e-Version enables wider reach of the magazine without printing extra copies. This in turn will reduce usage of paper.

If you have access to internet, we would request you to kindly opt for the e-version of *Dream 2047* and help us in our effort towards a greener environment. Kindly send a mail to dream2047@vigyanprasar.gov.in with 'e-version only' as the subject.

If you however wish to continue receiving the print copy and desire the e-version also kindly send the email with subject line 'e-version and print copy'.

This is a flagship activity of Vigyan Prasar and we invest a lot of time and effort in each issue. We believe each copy is used by several readers and often retained for reference purposes. Please send your comments and responses to the activities and editorial in each issue of the magazine. Each letter is read very carefully, in an attempt to improve the magazine.



Vigyan Prasar
and
DECU/ISRO
Jointly Presents



New Science Video Serial

'Our Celestial Neighbour-Far and Near'

Telecasting from 10th May, 2011 in

Every Tuesday on DD National at 09.30-10.00 am.

The 12 Episode series would provide a holistic view of Our Solar System and universe. The stars in the sky, planets wandering amidst has always been a source of wonderment. Who is not enchanted by the mysteries of space? In the past few decades humans have done much more than turning their head to sky and wondering; they have sent spacecraft to all the planets and studies them at close quarters. The 12 part serial, Our Celestial neighbour is an engaging fully animated programme designed to attract the young and old alike.



Vigyan Prasar
and
Lok Sabha TV



Jointly Presents Weekly Science News Programme

'Science this Week' (In English)

'Vigyan Darpan' (In Hindi)

Every Thursday (In Hindi) and Friday (In English)
on Lok Sabha TV at 09.30-10.00 PM

With an innovative idea to explore and depict happenings in the field of science and technology, Vigyan Prasar has come up with a challenging task of producing weekly science news capsules for Lok Sabha TV on every thursday and Friday during 09.30 to 10.00 PM. Known as 'Science this Week' in English and 'Vigyan Darpan' in Hindi, the weekly news covers important national and international events, discoveries and happenings in the field of science and technology.

Letters to the editor

Why impose Hindi?

I read your editorial in *Dream 2047*. Generally I am appreciative of the good work you are doing. Unfortunately, in your editorial in June you had advocated use of Hindi. I am surprised that you have forgotten that only 40% of the Indian population speaks Hindi. We, from Tamilnadu, are fervent critics of imposing Hindi on those who do not have Hindi as mother tongue. I am worried you have forgotten this and indirectly your approach might encourage people who are imposing Hindi on non-Hindi-speaking people to continue to do so. That I think would be a very wrong approach to nation building.

Why impose Hindi on us when we do not want to take up this additional burden? What happens to our cultural diversity if we sideline other languages many of which are classical languages? Don't you see you have a problem in your approach?

RMP Jawahar
Trichy

Comprehensive editorials

I have been a regular reader of *Dream 2047* for the last six years. Its editorial's explore the reader's mind in a comprehensive, dispassionate manner. Congratulations for a very well produced and informed magazine.

Raj Rajeshwar Malinda
Ward No. 15, Neem-ka-Thana
Sikar (Raj.) – 332713

Improves ideas about science

We would like to say our sincere thanks for publishing such nice magazine. It helps improve a person's intellectual ideas about science, which is highly important for daily life. It makes the readers aware of ancient and recent developments in science. *Dream 2047* can contribute to India emerging as a super-power in science in the near future.

Nibedita Devi
Banamali Sabar
Sabitri Sabar

Useful to teachers and students

I have been reading the magazine *Dream 2047* for the last four months. I have found it quite useful and also inspiring to both teachers and students of science. Your editorials are thought-provoking, informative, and above all make interesting reading. You touch upon the latest happenings in science and technology which is required for all those involved in science education. The articles also appear to be specially written to encourage student and teachers and motivate them to work in basis sciences. You have been doing a commendable job in India.

Shri Amit Kumar
V.P.O. Dharampura
Teh. : Aboher, Dist.: Ferozpur
Punjab – 152128
