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Soaps and Detergents

Nicolas
Leblanc



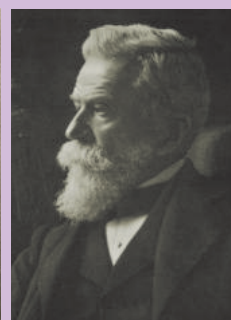
(1742-1806)

Michel Eugene
Chevreul



(1786-1889)

Ernest
Solvay



(1838-1922)

Inside

Editorial: Accelerating Sustainable Development 35

Soaps and Detergents 34

China's Growing Technology Prowess 31

Incredible science behind cat lapping milk 28

Managing and Treating Hypothyroidism 27

Recent Developments in Science and Technology 24

VP News 21

Accelerating Sustainable Development



Sustainable development aims at meeting needs of the society – present needs and that of the future. Used first by the Brundtland Commission, the term has come to mean a pattern of resource use that does not compromise the ability of future generations to meet their current needs.

Meeting the social challenges facing the society without disturbing Nature's equilibrium is the desired scenario. This calls for environmental, economic and socio-political sustainability.

There is an obvious interdependency between environmental protection and economic development. Integration and participation (and not confrontation) are key building blocks in this scheme. Access to information, improved awareness and ability to take wise decisions are emphasised. Competing goals need to be balanced without deviating from the target of improving the quality of life of the common man. One can well understand the challenge of finding the path by the government between the demands of the investors and the needs of the people.

Business schools generally are focussed on the growth of corporate entities and supporting entrepreneurial innovations. There should be more time for the young management students to understand concerns for ecology that would reveal tension between eco-centrism and anthropocentrism. A systems approach to growth and development will manage a balance between natural, economic and social capital. How can we recruit better teachers?

The last two decades has been witness to sustainability metrics and indices. Energy Efficiency Stars, Carbon Footprints of products and services are gaining currency. The developing societies have often viewed these with skepticism and criticism. Realisation must come that sustainability of human life is at stake and blind acceleration will hasten our extinction. Can we have planners with more perspective?

Some East Asian economies have recorded impressive growth in the same period as compared to other countries in the region and in other parts of Asia, Africa and Central America. A complex combination of factors is indicated as responsible for such success. Growth of technology obviously does not take place in isolation. Understanding this is important for those who seek to transplant technology to other regions of the world and in the case of India to some states.

Competitive technology development has to occur in the space provided by the S&T Policy, basic science and engineering capacity, and cooperation between researchers, generators and users of technologies. Inefficient subsidies, lack of accountability, and tight market controls have been replaced with market friendly regimes. This has encouraged inflow of technologies, export oriented investments and support to indigenous innovation. Electronics, automobiles, pharmaceuticals and petrochemical sectors served to bring Taiwan, Hong Kong, Singapore, Malaysia and South Korea in league with Japan. How can we have higher self-worth?

Lessons from the East Asian Tigers or the Chinese (manufacturing) Dragon are aplenty. Low overheads have leveraged high efficiencies and this has coincided with the stage of their development. Agrarian growth has kept pace with increasing population depending on manufacturing and service sectors. Forecasts are encouraging and can guide planning in perspective.

Improving scientific literacy in our work force – of both organised and informal sectors – would improve our productivity. Floor supervisors often drawn from workers would have better understanding of the micro and macro factors.

Integrating life skills in formal lessons of science and technology in the open school system, over the last few months, has provided an opportunity to contribute to this effort. Mentors, writers, illustrators and editors have struggled with the challenge. This is a significant start that will begin to impact on the economy shortly.

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Soaps and Detergents

“When water is used for washing, it dissolves dirt. But some dirt will not dissolve in water. Oily dirt will not dissolve. Detergents help oil to dissolve in water. Soap was the first detergent. People have been using soap for a very long time.”

Cambridge Coordinated Science: Chemistry by Geoff Jones, Mary Jones and David Acaster, Cambridge University Press, Cambridge, 1993

“The early synthetic detergent molecules were not biodegradable, and they caused pollution problems in rivers and streams. By changing the structure of the hydrophobic chain, modern soapless detergents are now biodegradable.”

Chemistry by Richard Harwood, Cambridge University Press (Low Price Editions), Cambridge, 1999

Chemically, soaps that are used as cleansing agents are water soluble sodium or potassium salts of fatty acids. The bar soaps with different shapes and sizes with which we are so familiar are made by casting soap compounds mixed with fragrance and other ingredients into desired shapes and sizes. Soap is a surfactant that is a surface active agent which when dissolved in water gives the resulting solution the ability to remove dirt from surfaces like human skin, textiles and wood, plastic and metal surfaces. A surfactant reduces the surface tension of water. A surfactant molecule consists of a hydrophilic or ‘water-loving’ head and a hydrophobic or ‘water-hating’ tail. A detergent is a surfactant or a mixture of surfactants that acts as a cleansing agent in dilute solution. Soaps and detergents used in our homes can be classified into four categories—personal cleansing, laundry, dishwashing, and household cleansing.

The origin of the word ‘soap’

The word ‘soap’ is derived from the Latin word *sapo*. The Latin word *sapo* first appears in Pliny the Elder’s (23-79 CE) *Historia Naturalis*. Pliny the Elder (Gaius Plinius Secundus), the Roman naturalist and author, described the process of making soap from tallow and ashes, but regarding its use, he only mentioned its use



Pliny the Elder

as a pomade or perfumed dressing for the hair. It appears that Pliny the Elder was unaware of the detergent power of soap.

The earliest evidence of soap-making

The earliest recorded evidence of making soap or soap-like materials dates back to around 2800 BCE in Ancient Babylon—clay jars of that period found in excavation contain soap-like materials. There is no consensus on the possible use of the soapy substances by the Ancient Babylonians. Some think that the soapy substance was used for the preparation of the wool for weaving and some others think that it was used for washing garments. A Babylonian clay tablet of around 2200 BCE has a formula for soap consisting of water, alkali and cassia (a coarse variety of cinnamon) oil written on it.

The Elbers Papyrus, an Egyptian document from about 1500 BCE indicates that the Ancient Egyptians prepared a soap-like substance by combining animal and vegetable oils with natron, an alkaline salt harvested from lakebeds. Egyptians used such primitive soaps for treating certain skin diseases as well as a cleansing agent.



Claudius Galen

Claudius Galen (129-200 CE), Greek physician and writer on medicine describes soap-making with lye (an alkali solution) and he prescribes washing using soap to carry away impurities from the body and clothes. It is usually regarded that Galen’s description of soap was the first definitive description of soap. Since Galen noted comparative qualities of different available soaps, it may be said that soap production was in practice for quite long at the time of Galen’s writing.

By the 7th century CE, the art of soap-making was well-known in parts of Europe. Soap guilds were formed and these guilds guarded their trade secrets closely

The chemical nature of soap

Soap is a salt of a higher fatty acid like stearic and palmitic acid. A soap molecule has a long hydrocarbon chain attached to a carboxylic acid group bonded to metal ion like sodium and potassium. The hydrocarbon part of the soap molecule is not soluble in water but soluble in non-polar solvent. The part of the molecule containing the carboxylic acid group bonded to metal ion is the ionic end and which is soluble in water.

Saponification

The process by which chemicals are converted into soap is known as saponification. It involves the alkaline hydrolysis of a fat or oil, or the neutralisation of a fatty acid. A soap-molecule is formed by reacting fats or oils with a strong alkaline solution (usually sodium or potassium hydroxide). Fats and oils are triglycerides (triesters of fatty acids)



non-polar end

Sodium stearate, a typical soap molecule

polar end



Dr. Subodh Mahanti

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$\text{OH-CH}_2\text{-CH(OH)-CH}_2\text{-OH}$	—————	Glycerol ($\text{C}_3\text{O}_3\text{H}_8$)
$\text{CH}_3\text{-(CH}_2\text{)}_{16}\text{-COOH}$	—————	Stearic acid ($\text{C}_{18}\text{H}_{35}\text{O}_2$)
$\text{CH}_3\text{-(CH}_2\text{)}_5\text{-CH=CH-(CH}_2\text{)}_7\text{-COOH}$	—————	Palmitoleic acid ($\text{C}_{16}\text{H}_{30}\text{O}_2$)
$\text{CH}_3\text{-(CH}_2\text{)}_7\text{-CH=CH-(CH}_2\text{)}_7\text{-COOH}$	—————	Oleic acid ($\text{C}_{18}\text{H}_{34}\text{O}_2$)
$\text{CH}_3\text{-(CH}_2\text{)}_4\text{-CH=CH-CH}_2\text{-CH=CH-(CH}_2\text{)}_7\text{-COOH}$	—————	Linoleic acid ($\text{C}_{18}\text{H}_{32}\text{O}_2$)

The molecular structures and molecular formulae of four fatty acids (one saturated and three unsaturated) from which fats/oils are made

formed by three molecules of fatty acids attached to a single molecule of glycerol. The alkaline solution transforms triglyceride molecules into salts of fatty acids or soap molecules and glycerol is liberated as a byproduct.

The nature of soap produced by saponification depends on the alkali metal and also on the type of fats/oils used. Sodium soaps that are soaps produced by using sodium hydroxide are harder but potassium soaps are softer or often liquid. Lithium soaps also tend to be harder and they are exclusively used in greases. Each fat or oil used in soap-making leads to different soap properties. For example, olive oil is very moisturising but does not lather much; on the other hand coconut oil can be drying but produce much greater lather.

How soaps are made

Before the Industrial Revolution the soap-making process was conducted on a small scale and the product was rough. It was during the Industrial Revolution the soap-making process was upgraded for commercial production. The quality of handmade soaps are different from the industrial soaps. Industrially manufactured bar soaps were first introduced in the market in the late eighteenth century. Among the pioneers in soap business were Andrew Pears, Francis Pears, Thomas J. Baratt, Robert Spear Hudson, Benjamin T. Babbit, William Hesketh Lever and his brother James Lever.

The first major hurdle in undertaking large-scale soap production was the unavailability of alkali in enough quantities. In fact the French Academy of Sciences with the patronage of the King of France Louis XVI (1754-1793) offered a prize of



Nicolas Leblanc

2400 livres (livre was an old French money of account originally equal in value to a pound of silver) to anyone who could develop a method to produce alkali from salt. Nicolas Leblanc (1742-1806), a French physician, found out a solution in 1791. Leblanc first reacted common salt with sulphuric acid to produce gaseous hydrochloric acid and sodium sulphate, which in turn was mixed with crushed limestone (calcium carbonate) and coal (carbon) and heated. In the process carbon was oxidised and black ash, a mixture of sodium carbonate and calcium sulphide was left behind. The sodium carbonate, a water soluble compound, was extracted by washing the black ash with water.



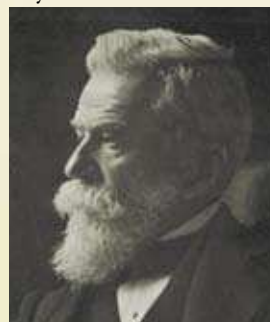
Michel Eugene Chevreul

It was Michel Eugene Chevreul (1786-1889), a French chemist, who discovered the chemical nature and relationship of fats, glycerin and fatty acids at the beginning of the nineteenth century. Chevreul's studies established the basis for both fat and soap

chemistry and thereby laid the foundation of the science of modern soap-making.

In the middle of the nineteenth century the Belgium industrial chemist Ernest Solvay's (1838-1922) process for producing sodium hydroxide (soda ash) not only further reduced the production cost of this alkali but also improved both the quality and quantity of the soda ash available for manufacturing soap.

Soaps are formed by reacting fats and oils under suitable conditions with liquid alkali to produce soap and water plus glycerine. The other method involves hydrolysis of



Ernest Solvay

fats and oils with high-pressure steam which produces crude fatty acids and glycerine. The fatty acids are purified by distillation and then neutralised with alkalis to produce soap. The manufacture of soaps and detergents involves a broad range of processing and packaging operation.

After the completion of the saponification processes, the soap is purified by removing the excess alkali, glycerol and other impurities by boiling the crude soap in water and re-precipitating the soap with salt. Then most of the water is removed from the soap using sprayer dryers or vacuum dryers. The dry soap containing about 6-12 percent moisture is converted into small pellets. The raw soap pellets are converted into salable products by a process called soap finishing. Fragrances and other materials are added to crude soap pellets and then blended to homogeneity in an amalgamator or mixer before further processing.

For producing a scouring soap, sand or pumice is added. The scouring agents help remove dead skin cells from the surface by a process called exfoliation. Nanoscopic metals are commonly added to certain soaps for both coloration and antibacterial properties.

Detergents

The first synthetic detergent was developed in Germany. The need for developing synthetic detergents arose from the shortage of fats and oils normally used in making soaps during the First World War. However, it is also true that the felt need for cleaning agent that unlike soap would not combine with mineral salts in water to produce an insoluble substance called soap curd also contributed to the discovery of detergents. The synthetic detergents, which are today simply called detergents are non-soap washing and cleansing products. They are commonly available as powders or concentrated solutions. The development of detergents was further hastened by the Second World War when there was again shortage of oils and fats. Moreover there was a military need for developing a cleaning agent which would be effective in sea-water and water rich in metallic salts. By 1953, the use of detergents surpassed that of soaps.

Based on the electrical

charge of the surfactant, detergents are classified into the following groups— anionic cationic, non-ionic and amphoteric /zwitterionic .

Anionic detergents are the ones most widely used for laundering, dishwashing liquids, and shampoos. Such detergents are called anionic detergents because in solution their hydrophilic ends are negatively charged. Alkyl sulphates (linear or branched) and alkyl ethoxyate sulphates are common examples of anionic detergents.

Cationic detergents display positively charged hydrophilic heads in solution. They are used as fabric softeners, laundry detergents and household and bathroom cleaners. Esterquat and mono alkyl quaternary system are examples of cationic detergents.

Non-ionic detergents have no electrical charge and so they are resistant to water deactivation. Most laundry detergents contain both non-ionic and ionic surfactants. Ethers of fatty acids are the most commonly used non-ionic detergents.

Amphoteric/zwitterionic detergents have no fixed charge, they can be negatively charged (anionic), positively charged (cationic) and non-ionic (no charge) in solution depending on the pH. Such detergents are often used as shampoos and cosmetic products. Alkyl betaine is an example of amphoteric/zwitterionic detergent.

How soaps and detergents work

Under normal circumstances water does not wet things very uniformly. This is because the water has a property known as surface tension. This property makes water molecules tend to stick together in drops. Each water molecule is surrounded and attracted by other water molecules. The water molecules at the surface are pulled into the body of the water as the molecules surrounded by other water molecules are on the water side. As a result a tension is created. So to make water wash better it is necessary to reduce its surface tension so that it can wet things more uniformly. Soap and detergent molecules reduce water's surface tension and improve its ability to wet things, spread over surfaces and penetrate into dirty clothes fibers.

This is not the only factor which makes soap and detergent effective in washing. Water cannot remove oily and greasy dirt

Continued on page 29



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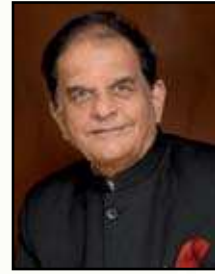


Timings for Radio Serial in different languages

Language	Production Centre	State	Broadcast Centre	Timings (Every Week)
Hindi	Delhi	Delhi A & N A'chal Pradesh Bihar Chattisgarh Haryana H.P. J&K Jharkhand M.P. Meghalaya Rajasthan Uttarakhand U.P.	Delhi-A Port Blair I Itanagar, Passighat Patna, Bhagalpur, Sasaram, Darbhanga Raipur, Jagdalpur, Ambikapur Hissar, Kurukshetra, Rohtak Dharamshala, Shimla Jammu, Leh Jamshedpur, Daltoganj, Ranchi Bhopal, Indore, Jabalpur, Chhatarpur, Gwalior, Rewa NES, Shillong Jaipur, Jodhpur, Barmer, Suratgarh, Bikaner, Udaipur Almora, Pauri Agra, Gorakhpur, Lucknow, Faizabad, Jhansi, Mathura, Najibabad, Rampur, Varanasi, Allahabad	(Sun) 09.10-09.40 AM
English	Delhi	Delhi Meghalaya T.N. Maharashtra W.B.	Tura Chennai-B Mumbai-B Kolkata-B	(Sun) 09.30-10.00 PM
Telugu	Hyderabad	A.P.	Hyderabad-A, Vijayawada, Cuddapah, Adilabad, Tirupati, Visakhapatnam	(Sun) 9.35-10.05 AM
Assamese	Guwahati	Assam	Guwahati, Dibrugarh	(Sun) 9.50-10.20 AM
Konkani	Panaji	Goa	Panaji	(Sun) 9.30-10.00 AM
Gujarati	Ahmedabad	Gujarat	Ahmedabad, Bhuj, Rajkot, Godhra	(Mon) 9.30-10.00 PM
Kashmiri	Srinagar	J&K	Srinagar	(Tue) 9.30-10.00 PM
Kannada	Bangalore	Karnataka	Bangalore, Bhadravati, Mysore, Dharwad, Gulbarga	(Sun) 08.35-9.05 AM
Malyalayam	Thiruvananthapuram	Kerala	Calicut (Kozhikode), Trichur, Trivandrum	(Wed) 08.00 -8.30 PM
Marathi	Pune	Maharashtra	Nagpur, Ahmednagar, Aurangabad, Pune, Jalgaon, Kolhapur, Sangli, Mumbai-A Ratnagir, Parbani	(Sun)07.25-7.55 AM
Manipuri	Imphal	Manipur	Imphal	(Sun) 06.40-07.10 AM
Khasi	Shillong	Meghalaya	Shillong	(Sun) 09.10-9.40 AM
Mizo	Aizawl	Mizoram	Aizawl	(Sat) 8.35-09.05 AM
Nagamese	Kohima	Nagaland	Kohima	(Tue) 12.30 N-1.00 PM
Oriya	Cuttack	Orissa	Cuttack, Sambalpur, Behrampur, Jeyapore Bhawanipatna, Rourkela, Baripada	(Sun) 8.30-9.00 AM
Punjabi	Jalandhar	Punjab	Bhatinda, Jalandhar, Patiala	(Sun) 10.00 -10.30AM
Nepali	Gangtok	Sikkim W.B.	Gangtok Kurseong	(Sat) 9.30-10.00 PM
Tamil	Madurai	T.N. Pondicherry	Chennai-A, Combatore, Madurai, Tiruchirapalli, Tirunelveli, Karaikal Pondicherry	(Sat) 08.00-8.30 PM
Bengali	Kolkata	Tripura W.B. Assam	Agartala, Kailashahar Kolkata-A, Murshidabad, Siliguri Silchar	(Sun) 11.00-11.30 AM

(For details see the website www.vigyanprasar.gov.in)

China's Growing Technology Prowess



P. S. Deodhar*

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China has been recognised as the factory of the world for over a decade. Everywhere in the world, almost all products that supermarkets carry are directly or indirectly produced in China. This clearly shows that Chinese products have quality that is acceptable to quality-conscious customers, especially in western Europe. Many in India today, however, believe that “made in China” toys, luggage and other consumer goods are cheap goods of undependable quality. This happens because our Indian traders who buy from China demand cheapest prices with no respect for quality. Some Chinese suppliers oblige them; after all it is big business for them.

Even in western countries, however, people believe that the Chinese are just imitators, subcontractors for products designed in other countries. Over 66% of China's exports fall in this class. Multinational companies procure their production from China either from their own factories in China or by using several Chinese subcontractors, mostly from industrial clusters of Chinese small and medium enterprises (SMEs). This procurement process essentially involves technology and knowhow transfer for new materials, associated technical processes and product packaging to Chinese engineers and technicians working for SME subcontractors.

Hi-Tech knowhow is a mystery as long as it is closely held. Once open it is often simple for recipient Chinese engineers. Inevitably this ‘*shagirdi*’ turns out to be an excellent way to learn the world's best practices in manufacturing and process management. It has also helped China to inculcate a high-quality work culture on their factory floors resulting in productivity unachievable in our factories in India. Chinese engineers and technologists are learning fast and now many are not only mastering what they learn but innovating further. The country is no more a maker of consumer goods but today it is a major producer of computer chips, IT and telecommunication products, automobiles and even commercial aircrafts. Many semiconductor fabrication plants (fabs) are also in China. 70 to 75% of laptops,

cellular phones, telecom products of every variety sold in the world are produced in China. Most new models are also designed in China. It may be interesting to note that till 1998, China imported 90% of complete telecommunication equipment and after just four years, from 2002, this has come down to below 10%.

A visit to China's huge annual Hi-Tech Show during the last two years, 2009 and 2010, have convinced us that the country is rapidly ascending on technology ladder, climbing from mere imitators and subcontractors to become independent developers, product innovators and pace setters. There is no other country, including India, that has set such high goals in technology and has made organised planning to achieve them at such a rapid pace. The proof of China's growing strengths in technology became visible when it leapfrogged to set new global standards in cellular phones, video compression, electric vehicles, etc.

The Chinese government is achieving its technological goal progressively with very clever planning. Thoughtfully, in its initial phase, China leveraged foreign investments by the multinational technology companies to ensure this to happen. Chairman Deng Xiaoping had an extremely clear vision at the outset. He envisioned the need to learn from the west technological and economic progress and gave up China's deeply communist postures taken during Chairman Mao's times. Deng Xiaoping's pragmatic approach was clear when he said, “The colour of the cat does not matter as long as it could catch mice”. The Chinese realised that joint venture is the best way to ensure transfer of knowledge and technology comprehensively. As against this, in India, we allowed our trader-managed industries to import production lines and ‘buy’ technology during our Permit Raj. Instead China liberally allowed even 100% ownership to foreign investors, especially when technology was of supreme importance to China. Cheap, competent and disciplined labour (with ban on strikes) and free access to China's large domestic market attracted western multinationals. The ease of manufacturing in China was supplemented

by quickly investing in creating a world class infrastructure with huge mechanised ports, a network of expressways and other logistic inputs.

Such incentives to technology transfer worked very well. The government in Beijing turned China into a global factory by the end of 90s. Almost all Fortune 500 global giants moved their manufacturing to China. This also enabled China to rapidly get technology related to innumerable hi-tech industrial sectors like in energy, micro-circuits, micro-mechanical devices, maglev transportation, and intelligent products with embedded controllers, sensors, actuators, etc. I recollect a 1982 report from Macintosh Consultants submitted to the British Government on technology. It says that the technology cannot ever be purchased; it has to be either acquired or stolen. The guys at Macintosh did not realise that greed for profits was another way that Chinese found to get and inculcate modern technologies without ever paying for them.

Research & Development: Role of universities

China however still has a long way to go before it can catch up with the US when it comes to scientific research and reaching for new knowledge. But China has another plan for acquiring R & D capabilities in modern technologies through its universities.

Till the end of the 70s, China had concentrated on R & D efforts in fields of defence and heavy industry, mostly in public sector enterprises similar to the Soviet model that we too followed. Once China embraced reforms in 1978, it gave up the Soviet model and supported personal innovation and enterprise, adopting a new modern style approach. Today we find a large number of university incubated private high-tech enterprises called “Xiao ban” (*pronounced as shaoban*) all over China. They have grown into the leading players of the Chinese hi-tech industry. This is helping China to evolve

as a nation with its economic growth based on industrial production and technology development rather than growth through trading.

Zhongguancun, formerly a tranquil rural suburb of Beijing, is today China's Silicon Valley. Xiaobans here include state-of-the-art silicon foundries producing ICs with sub-micron geometry and many others developing and producing micro-mechanical peripherals. This area is home to some 30 universities including the famous Tsinghua Beijing University. The Chinese Academy of Sciences based here is also a proactive research organisation not just an administrative body. According to the Chinese Ministry of Education's statistics, in 2003, 364 universities operate 2,490 hi-tech enterprises and these earned 52.8 billion RMB, (Rs. 19,000 crores approx) amounting to 75 percent of universities total revenues and generated profits of more than 4.5 billion RMB. These enterprises had 320,000 employees including 88,000 specialists in science and technology. Many of these were university post graduate students. It is noteworthy that these enterprises also carried out their basic mission providing practical training to university students, with some 780,000 students engaged in research activities in those enterprises. Beijing Tsinghua University have been shouldering roughly half of their expenses of academic activity with profits from their affiliated enterprises. In fact, the government expects university-affiliated enterprises to make up for the shortage in its higher education budget. Indian universities and its faculties have to ponder and understand the consequences for our young due to total lack of focus on knowledge pursuits.

The university-affiliated enterprises in China are entitled to a series of preferential taxes including income tax. There are no limits set for liabilities incurred by a university in the event that its affiliated enterprise goes under. And by doing so, it would become possible to create an environment that allows for universities to concentrate, to a greater extent, on their original duties of education and research activities. Tsinghua is an institution that has produced several top executives to the Chinese government, including Hu Jintao, who is today the President of China. Jiao Tong University in Shanghai is the alma mater of Jiang Zemin, the former President of China.

These universities are not only China's top elite schools but also excellent scientific institutions. It is said that approximately 7,000 graduates from Tsinghua University alone are residing in the San Francisco Bay area, including Silicon Valley, and so this university works as a supply source of human resource that supports the development of even the US economy.

R & D joint ventures with Chinese industries

Since 2004, Chinese government has been proactively encouraging joint ventures in research and development by multinationals with Xiaobans and other Chinese partners. Chinese universities are today engaged in research and development of applied technologies with practical use. Therefore Chinese universities are attracting joint research with foreign enterprises. This is applied technology, where such enterprises develop products based on established basic technologies. Thus, foreign enterprises cooperating with Chinese universities are more than happy since they can utilise their own established technologies and other available in their countries, to open up new markets in the world.

Establishing R & D centres on Chinese soil has been a major priority for Chinese authorities since 2004. In addition to General Motors and GE, such R & D joint ventures are now functional for Oracle, Siemens, Lucent, Nokia, Nortel, Agilent, IBM and Hewlett Packard. In all about 215 such centres are now functional. The access to domestic business is also used to encourage foreign companies to share technology. For Intel and GE, China is today a very big market. Both share technology with China to retain that access. For instance, GE conceded key turbine technology to its Chinese competitors to gain a large turbine contract. A recent survey by Peter Buckley and his associates shows that foreign investments in China generated considerable technology spill over which Chinese companies are using to their advantage.

International patents in Hi Tech

One measure of a nation's R & D strength is the number of international patents filed by its scientists and innovators. According to the OECD report related to hi tech 'ICT' (Information & Communication

Technology) Patents in 2005; US had a 38% share followed by Japan (18.7%), Germany (7.7%) and China (4.2%). Another telling fact is that only five years back, China's share was just 0.3%. The Chinese patents are mainly related to functional design features and packaging rather than new inventions. It is surprising that the share of a self-proclaimed IT superpower India, in spite of money spinning TCS, Infosys and Wipro, was just below 0.4%! This reveals Chinese motivated efforts to get technology and also the neglect of making planned R & D investments by our big businesses as well as state and central governments.

It is clear that joint ventures and foreign owned businesses in China help spill over of technology and process and material knowledge to Chinese companies and SMEs. Even in joint ventures in R & D the technology transfer takes place. Chinese scientists and engineers working in these centres are not robots but technical talents eager to learn. The adaptation of research develops skills and insights that can later be used for core development tasks. China today is the 7th largest recipient of overseas R & D expenditure by US firms (over one billion US dollars) according to the National Research Foundation of USA.

Human resource: Overseas Chinese and people of Chinese origin

Unlike India, every Chinese below the age of 30 today is fully literate having gone to a formal school at least for seven years followed by either university or livelihood skills training. China's work force today is literate. Nothing helps technology inculcation better than literate work force on the shop floor. It is reflected in China's amazing productivity on their shop floors. Literacy rate is 98%. However, China's greatest human resource is overseas Chinese working and studying abroad. Chinese people from Hong Kong and Taiwan and those from other Asian nations like Singapore, Malaysia, and Indonesia, etc., also form a Chinese technical talent pool. Post-liberation, Hong Kong immediately opened a wide window for Mainland China to the global economy. Over 40% of FDI in China comes from Hong Kong. A well defined economic policy (that kept a wide distance from its international political policies) by the Chinese government in Beijing encouraged Hong Kong and Taiwan

companies to use low-cost disciplined Chinese labour as well as other incentives to move their factories to China. Hong Kong since 1997 is now a part of the PRC and the entire manufacturing in Hong Kong has now moved to Mainland China. China may have a serious militarily confrontational dispute with Taiwan, but almost all Taiwanese own factories in China and many of them have settled in China. The Taiwanese have decades of experience in Hi-tech field. I recollect that during my visit to Shanghai in 1983, China's only semiconductor factory had just established an IC making foundry with Taiwanese help and were producing chips equivalent to Intel's 8080. This was the same year that China almost attacked Taiwan militarily!

As a policy the Chinese government encourages its students to join foreign universities. In 2005 there were 123,000 Chinese students studying in US of whom

78,000 were from PRC and the balance was from Hong Kong and Taiwan. Indian students also go abroad to study in hordes matching China's numbers. We used to call that 'brain drain'. In 1986, while discussing this with Rajiv Gandhi, my friend Dr. Abid Hussain put it differently. He said, "Brain drain is better than brain in drain". For the Chinese, it was a way to acquire modern technology and enrich human resources. Like Indians abroad, most Chinese students in the early 80s did not want to return home. But in 1995, only 11% of Chinese PhDs chose to work in the US and others returned to China where opportunities were ever expanding. Unlike India, China offers huge incentives to return. The financial assistance comes in large measures. There is evidence that a large number of elderly successful Chinese scientists and technologists are now returning home even after decades of stay in the US. They bring along with them not

only technology knowhow but also executive and international savvy that are essential in the global market place.

As China gets economically stronger its bargaining power will be stronger to get foreign companies to share and transfer technology. The Chinese have also been following Macintosh Consultants advice not to buy technology but steal it. The country already has shown nerves of steel. The Chinese government will continue to turn a blind eye to companies who blatantly indulge in piracy of intelligent property and indulge in counterfeiting patented products.

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Continued from page 32 (Soaps and Detergents)

because these substances are not dissolved in water. Soaps and detergents, because of their typical chemistry, have the ability to emulsify or disperse water insoluble materials like oily and greasy dirt and held them in suspension in water. In water, which a polar solvent, soap or detergent molecules form clusters in the form of tiny spheres, known as micelles. The micelle has a cell-like structure formed by the aggregation of soap subunits. The exterior of such a cluster is hydrophilic (or attracted to water) is formed by the polar carboxylate groups. The interior, or the hydrophobic packet formed by the hydrocarbon chains which can surround the sticky oily or greasy particles and allow them to "dissolve" in water. While water-hating end is repelled by water but gets attracted to oily or greasy dirt, the water-loving end is attracted to the water molecules. These two opposing forces loosen the sticky oily or greasy dirt and suspend it in the water. So, while under normal conditions oil and grease do not mix with water, the addition of soaps and detergents allow them to be carried away by water.

It may be noted that while the sodium and potassium salts of most carboxylic acids are water soluble, the calcium, magnesium and iron salts are not. Soap molecules react with metal ions like calcium (Ca), magnesium (Mg) and iron (Fe) present in the water (hard water contains these metal ions) to form water-insoluble precipitate

called "soap scum". Even when soft water is used for cleaning, hardness-causing elements like calcium, magnesium and iron may be introduced by the soil present on the dirty clothes. The formation of soap scum creates problems for cleaning because the process removes soap ions from solution and decreases the cleaning effectiveness of soaps. To remove this problem washing aids in the form of washing soda (sodium carbonate) and borax (sodium tetraborate) were introduced. These washing aids when added to the water would precipitate the metal ions and thereby prevent the formation of soap scum. Soap has some other disadvantage. It is not very easy to rinse away soap deposits; it tends to remain behind on the washed clothes. The soap deposits on clothes may produce visible effect and make fabrics feel stiff. The introduction of synthetic detergents made it possible for washing without washing aids. While detergents work in the same way as soaps, they do not precipitate with metal ions like calcium, magnesium and iron.

Use of soaps and detergents

As cleansing agents soaps and detergents play an essential role in our daily lives. They help us to stay healthy and care for our homes and other possessions. By cleaning they make our surrounding more pleasant. It should be noted that certain soaps are key components of most lubrication greases,

which are usually emulsions of lithium and calcium soaps. Lithium-based greases are widely used. Soaps with other metal ions are also used in lubrication greases. Soaps which are used in lubrication greases are sometimes classified as thickeners because they raise the viscosity of the oil.

The largest application of detergents is for cleaning clothing. Usually laundry detergents contain water softeners, surfactants, bleach, enzyme, brighteners, fragrances and many other agents. The temperature of the cleaning water determines the formulation and varies from country to country.

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Incredible science behind cat lapping milk



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Cats are crafty and astute; in fact often we describe a person who is sly and sneaky as cattish. Dogs in contrast are messy and cluttered. We are never able to catch a cat in its act of surreptitious theft of milk, but a dog is caught spot on. Place a cup of milk before a cat, it will slurp it up and leave no trace, not even its whiskers wet. Give a bowl of water to a dog, it would splatter and spill water all around and dog would be wet as well.

The way animals drink water is different from the way we drink it. When we drink usually place our head backwards and tip a cup to allow liquid to flow into our mouths. Or if we are sipping, then we typically open our mouth and suck water creating suction. This is possible because in humans, as well as sheep, horses and pigs, the cheeks are 'complete cheeks'. On the other hand carnivorous animals such as dogs and cats have 'incomplete cheeks' which enable them to wide open the mouth to catch the prey. Although

they can wide open their mouth they cannot close their cheeks and create a vacuum with their mouth. Hence they have to slurp rather than drink a liquid.

Intrigued as to how the lapping of water and milk by dogs and cats works, scientists investigated. High-speed photography showed that when dogs drink water, they extend their tongue out from the mouth and morph it into a 'cup'. Fully protruding tongue looks like a "J" shaped ladle. As their tongue enters the water, the 'cup' fills with liquid. The ladle-shaped tongue is then pulled into the mouth. Invariably in this process the water spills out and splashes. Lapping is messy.

Roman Stocker, a biophysicist (one who studies the physics of the biology!) was feeding his pet cat Cutta Cutta (Cutta Cutta means "stars stars" in an Australian aboriginal language) milk while he was taking his breakfast. The cat slurped the milk without spilling or splashing, Stocker noticed that the cat is never wet in its mouth. Until recently scientists had thought

that cats also transform their tongue in to "J" shape while drinking milk. 'But cat is far tidier than dog', wondered Stocker and he and his colleagues decided to investigate this puzzling phenomenon. They used a high-speed video camera that can take 1,000 pictures in a second and filmed the cat drinking milk many times.

The film could be run in slow motion and hence they could see the process very clearly. The video images clearly showed that



cat does not curve its tongue into "J" shaped ladle, only the tip of the tongue touched the surface of the liquid. Further the tongue did not dip deep into the liquid, but barely touched the surface before the cat rapidly drew its tongue back. As they attentively watched, a column of milk formed between the moving tongue and the liquid's surface. The column of milk mysteriously heaved from the surface, against gravity. As the milk column rises, the cat snaps its jaws shut at just the right moment, catching a mouthful of the liquid before it falls.

Close examination of the tongue of cat showed that the cat's secret weapon for lifting the milk is in its raspy tongue. As the protruding tongue touches, the milk adheres to the rough and coarse tongue due to surface tension. When the driver applies break to a moving bus suddenly, we fall towards the front due to inertia of motion. In the same way when the cat draws its tongue back up so rapidly into her mouth, the milk touching the tongue is also pulled along due to inertia. However, as the tongue goes up,

milk column is pulled down by gravity. Like tug of war inertia and gravity pull the milk column in two opposite directions. For a fraction of a second, inertia, which is pulling up the milk, overcomes gravity, which pulls the liquid back down toward the bowl. Just before gravity pulls the milk back, the cat swiftly snaps shuts its mouth. If the cat had waited, the column would have broken, the liquid would have fallen back into the bowl, and the tongue would have come up empty.

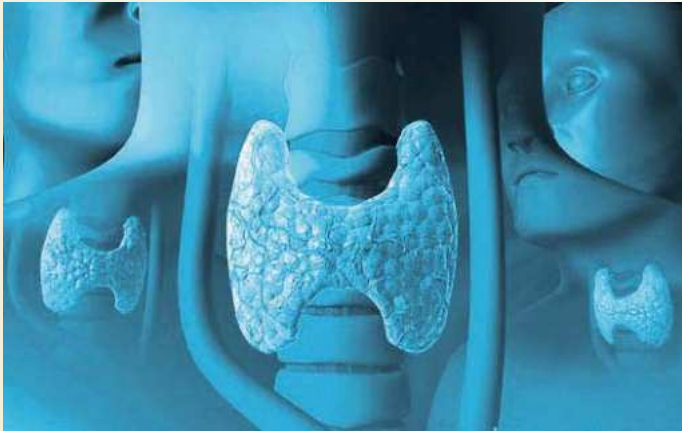
To experience this all you have to do is insert the tip of your index finger inside a bowl of water. Pull the finger all of a sudden and you will see that a water column is formed between your finger tip and the water bowl. If you watch closely you can indeed observe that the water column rises, albeit wee bit. The water that follows your finger up is pulled by the same inertia by which the cat also pulls up milk with tongue. To test their theory Stocker and his colleagues built a robotic version of cat's tongue that can move up and down over a dish of water. This enabled them to systematically study and explore different aspects of lapping and understand the mechanism underpinning it. It became clear that the cat's lapping mechanism is far more subtle and elegant and hence they drink very tidily.

The efficiency of lapping comes from the pace at which the cat can extend and withdraw its tongue and also the rapidity with which it can snap shut its mouth. The cat's tongue moves at the speed of one metre per second and it takes about six laps per second. But do only domestic cats drink this way? To answer that, Dr Stocker's team filmed a number of big cats drinking, including a lion and a tiger at the local zoo. They found that big cats also use the same lapping technique as cats; however, as they have larger and bigger tongues, they needed to lap more slowly to keep inertia and gravity in balance than cats. ■

Managing and Treating Hypothyroidism



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Untreated hypothyroidism can lead to a number of health problems. If the thyroid gland becomes enlarged, it causes a swelling to appear in the neck. This swelling is called goitre. Hypothyroidism can also be associated with heart problems, infertility, peripheral nerve inflammation, impaired functioning, birth defects in babies, and rarely, life-threatening situation, myxedema.

Complications of hypothyroidism

Goitre

Constant stimulation of the thyroid to release more hormones may cause the gland to become larger — a condition known as goitre. Hashimoto thyroiditis is one of the most common causes of goitre. Although generally not uncomfortable, a large goitre can affect a person's appearance and may interfere with swallowing or breathing.

Heart problems

Hypothyroidism may also be associated with an increased risk of heart disease, primarily because high levels of low-density lipoprotein (LDL) cholesterol — the “bad” cholesterol — can occur in people with an underactive thyroid.

Even subclinical hypothyroidism, a more benign condition than true hypothyroidism, can cause an increase in total cholesterol levels and impair the pumping ability of your heart. Hypothyroidism can also lead to an enlarged heart and heart failure.

Infertility

In women who are in the reproductive age, low levels of thyroid hormone can interfere with ovulation, which impairs fertility. In addition, some of the causes of hypothyroidism — such as autoimmune disorder — also impair fertility. Treating hypothyroidism

with thyroid hormone replacement therapy may not fully restore fertility. Other interventions may also be needed.

Birth defects

Babies born to women with untreated thyroid disease may have a higher risk of birth defects than babies born to healthy mothers may have. These children are also more prone to serious intellectual and developmental problems. Infants with untreated hypothyroidism present at birth are at risk of serious problems with both physical and mental development. However, if this condition is diagnosed within the first few months of life, the chances of normal development are excellent.

Peripheral neuropathy

Long-term uncontrolled hypothyroidism can cause damage to the peripheral nerves—the nerves that carry information from the brain and spinal cord to the rest of the body; for example, the arms and legs.

The signs and symptoms of peripheral neuropathy may include pain, numbness and tingling in the area affected by the nerve damage. It may also cause muscle weakness or loss of muscle control.

Mental health issues

Hypothyroidism can also affect mental functioning; leading to forgetfulness and slowing of intellectual function. The condition may also lead to depression early in the disease. The depression may become more severe over time.

Myxoedema

This rare, life-threatening condition is the result of long-term, undiagnosed hypothyroidism. Its signs and symptoms include intense cold intolerance and drowsiness followed by profound lethargy and unconsciousness. A myxedema coma may be triggered by sedatives, infection or other stress on the body.

If a person develops signs or symptoms of myxedema, s/he needs immediate emergency medical treatment.

Going to the doctor

Your family doctor or an internist may be the first doctor that you are likely to go to for seeking the advice. However, the expert best trained to handle the condition, is referred to as an endocrinologist.

Since appointments can be brief, and because there is often a lot of ground to cover, it is a good idea to be well prepared for the appointment. So preparing a list of questions will help you make the most of your time together. List your questions from most important to least important in case time runs out. Some basic questions you may wish to ask your doctor include:

- What is likely causing my symptoms or condition?
- Are there other possible causes for my symptoms or condition?
- What kinds of tests do I need?
- Is my condition likely temporary or chronic?
- What is the best course of action?
- What are the alternatives to the primary approach that you are suggesting?
- I have these other health conditions. How can I best manage them together?
- Are there any restrictions that I need to follow?
- Should I see a specialist? What will that cost?
- Is there an alternative to the medicine you are prescribing me?
- Are there any brochures or other printed material that I can take home with me?
- In addition to the questions that you have prepared to ask your doctor, don't hesitate to ask questions during your appointment.

What to expect from your doctor

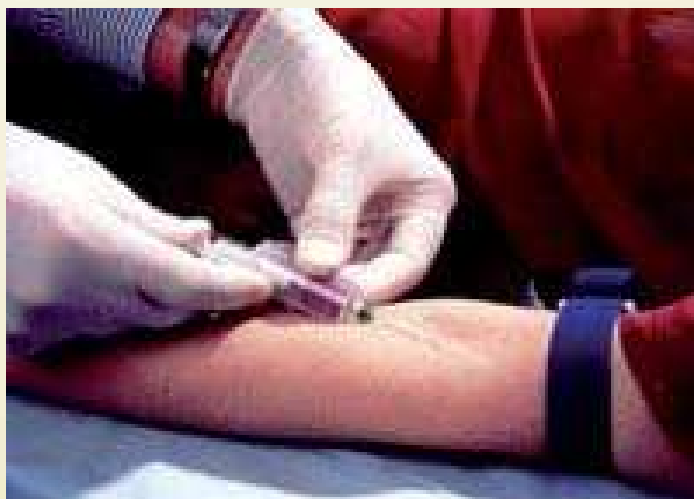
Your doctor is likely to ask you a number of questions. Being ready to answer them may reserve time to go over any points you want to spend more time on. Your doctor may ask:

- When did you first begin experiencing symptoms?
- Have your symptoms been continuous or occasional?
- How severe are your symptoms?
- What, if anything, seems to improve your symptoms?
- What, if anything, appears to worsen your symptoms?
- Did you ever undergo the tests for thyroid function before? If yes, what results were found?

Tests and diagnosis

In general, your doctor may test for an underactive thyroid if you are feeling increasingly tired or sluggish, have dry skin, constipation and a hoarse voice, or have had previous thyroid problems or goitre.

However, since hypothyroidism is more prevalent in older women, some doctors also recommend that older women be screened for the disorder during routine annual physical examinations. Some doctors also recommend that pregnant women or women thinking about becoming pregnant be tested for hypothyroidism.



Blood tests

Diagnosis of hypothyroidism is based on the symptoms and the results of blood tests that measure the level of TSH and sometimes the level of the thyroid hormone thyroxine. A low level of thyroxine and high level of TSH indicate an underactive thyroid. That is because the pituitary produces more TSH in an effort to stimulate the thyroid gland into producing more thyroid hormone.

In the past, doctors were not able to detect hypothyroidism until symptoms were fairly advanced. However, by now using the sensitive TSH test, doctors are able to diagnose thyroid disorders much earlier — often before a person develops any symptoms. Since the TSH test is the best screening test, the doctor will likely check TSH first and follow with a thyroid hormone test if needed. TSH tests also play an important role in managing hypothyroidism. They help your doctor determine the right dosage of medication, both initially and over time.

Thyroid scans and ultrasound tests

Sometimes your doctor may recommend an ultrasound or nuclear scan of the thyroid with the idea to evaluate the gland. While the ultrasound scan is able to obtain information about its inner architecture, the nuclear scan is capable of evaluating its function.



Subclinical hypothyroidism

The TSH tests are also used to help diagnose a condition called subclinical hypothyroidism, which usually causes no outward signs or symptoms. In this condition, a person may have normal blood levels of triiodothyronine and thyroxine, but higher than normal levels of TSH.

In a person with subclinical hypothyroidism, a specialist doctor must best decide the treatment. If the TSH is only showing a relatively mild increase, you probably won't benefit from thyroid hormone therapy. On the other hand, for a higher TSH level, thyroid hormones may improve the cholesterol level, the pumping ability of your heart and your energy level.

Medication for hypothyroidism

The treatment for hypothyroidism involves daily use of the synthetic thyroid hormone levothyroxine. This oral medication, which has to be taken daily, restores adequate hormone levels, shifting the body

back into normal gear. The medication is started at a low dose and the dose is increased gradually until an effective level is reached without causing side effects.

Medication takes time to yield benefit

The first positive changes are perceptible one to two weeks after starting treatment, and you will notice that you are feeling less fatigued, but it may take up to 6 months for the symptoms to disappear completely.

The medication also gradually lowers cholesterol levels elevated by the disease and may reverse any weight gain.

Determining proper dosage may take time

To determine the right dosage of levothyroxine initially, the doctor generally checks the level of TSH after two to three months. Excessive amounts of the hormone can cause side effects, such as:

- Increased appetite
- Insomnia
- Heart palpitations
- Shakiness

Making the most of treatment

Certain medications, supplements and even some foods may interfere with the absorption of the medication, levothyroxine. You must therefore avoid partaking large amounts of soy products or a high-fibre diet and must talk to your doctor if you take other medications, such as iron supplements, cholestyramine, aluminum hydroxide (which is found in some antacids) and calcium supplements.

Being careful

If you have coronary artery disease and severe hypothyroidism, your doctor may start treatment with a smaller amount of medication and gradually increase the dosage. Progressive hormone replacement allows your heart to adjust to the increase in metabolism.

Side effects

Levothyroxine causes virtually no side effects when used in the appropriate dose and is relatively inexpensive. Only if you take a higher than necessary dose, side effects may occur.

Lifelong treatment

Treatment with levothyroxine is usually life long, but because the dosage you need may change, your doctor is likely to check your TSH level every year. Don't skip doses or stop taking the drug because you're feeling better. If you do, the symptoms of hypothyroidism will gradually return.

Dietary tips and restrictions

If you have hypothyroidism, take thyroid hormone replacement as directed by your doctor — generally on an empty stomach. It is also important to note that too much dietary fibre can impair the absorption of synthetic thyroid hormone. Certain foods, supplements and medications can have the same effect. Therefore, you should avoid taking the medication (thyroid hormone) at the same time as:

- Walnuts
- Soybean flour
- Cottonseed meal
- Iron supplements or multivitamins containing iron
- Calcium supplements
- Antacids that contain aluminum or magnesium
- Some ulcer medications, such as sucralfate
- Some cholesterol-lowering drugs, such as cholestyramine and colestipol

To avoid potential interactions, eat these foods or use these products several hours before or after you take your thyroid medication.

Letters to the editor

Separate English and Hindi versions

I have been reading *Dream2047* for 5 year. I have a few suggestions for you.

The Hindi/English versions of *Dream 2047* into different magazines. Readers can choose either of the languages. I would also like you to increase the number of article. The telecast of VP science serials at 9.30 AM on Tuesday is not a proper time for students, teachers and other also. So the serials should be telecast at a more convenient time. I hope the *Dream2047* team would give attention to these suggestions.

Shashi Kanta Palai
Kismat Krushnapur
Basudevur, Bhadrak, Pin – 756125

A tool for inculcating scientific temper

I have been reading the magazine *Dream 2047* for the last eight years. I've found it quite useful and also inspiring to both teacher and student communities. The editorials are very comprehensive, scientific and could be helpful in creating awareness about recent social and scientific issues. Especially the articles in the recent development in Science and Technology are very unique and vital source for improving the awareness of recent issues among the people as well as students learners. I felt *Dream 2047* is the one of the tools for inculcating scientific temper and scientific attitude for social change in the future India. I wish you all the best for your future editions.

M.Sudurshan
Secretary
Albert Einstein Science Club (VIPNET CLUB)
Kandanpet, Pillaiyarkuppam Post,
Bahour Commune,
Puducherry-607 402

Excellent science magazine

I am thrilled to read the articles from various topics in the science magazine *DREAM 2047*. The language, presentation, picture depiction, and explanation of the contents are the key attraction of your magazine. It is really interesting and informative for disseminating the developments in science among the teachers and my students. I find detailed new information regarding usage and demerits of polymers, importance of compost manure, air pollution, and recent developments in science and technology, etc. I express my hearty thanks for this golden opportunity to read your esteemed magazine.

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Recent developments in science and technology

Planets without stars

Till now planets were found only in orbits around stars. The idea of planets floating free in space not held by the gravitational field of a star was inconceivable. But truth is sometimes stranger than fiction, and so it is with free-floating planets too. Recently, a



This artist's conception illustrates a Jupiter-like planet alone in the dark of space, floating freely without a parent star. Astronomers recently uncovered evidence for 10 such lone worlds, thought to have been ejected from developing solar systems.

team of astronomers have discovered at least 10 Jupiter-sized objects in the Milky Way galaxy that are very likely to be free-floating planets. For none of these 10 planets the researchers could find any trace of a parent star within 1.5 billion kilometres – about the distance Saturn orbits around our Sun. The team therefore concluded that the objects are either in orbits much larger than any previously observed or that they are wandering freely through interstellar space. The team believes these lone worlds are probably outcasts from developing planetary systems and they could be twice as numerous as the stars themselves. The planets are located at an average approximate distance of 10,000 to 20,000 light years from Earth (*Nature*, 19 May 2011). Scientists had previously believed that about 20% of stars had massive planets attached to them, but the new results suggest that there are at least

twice as many planets as stars, and probably their number is much larger.

The discovery is based on a joint Japan-New Zealand survey that scanned the centre of the Milky Way galaxy during 2006 and 2007, revealing evidence for up to 10 free-floating planets roughly the mass of Jupiter. The team, headed by astrophysicist Takahiro Sumi of Osaka University in Japan and colleagues, carried out the survey as part of the Microlensing Observations in Astrophysics (MOA), using the technique of 'microlensing' to make the discoveries. Microlensing events occur when something, such as a star or planet, passes in front of another more distant star. The passing body's gravity bends the light of the background star, causing it to magnify and brighten. How long the object remains brighter is a measure of the mass of the intervening body. Larger passing bodies, like massive stars, will bend

the light of the background star to a greater extent, resulting in brightening events that can last weeks. Small planet-size bodies will cause less of a distortion, and brighten a star for only a few days or less.

The researchers used the 1.8-metre telescope at Mount John University Observatory in New Zealand to scan over 50 million stars at the centre of the Milky Way galaxy to search for gravitational microlensing events. The observations were independently confirmed by a second group of scientists as part of the Optical Gravitational Lensing Experiment (OGLE), using a 1.3-metre telescope at Chile's Las Campanas Observatory.

Exoplanets are planets orbiting around stars other than the Sun. More than 500 exoplanets have been discovered in just over a decade of hunting by scientists and the vast majority of these are gravitationally bound



Biman Basu

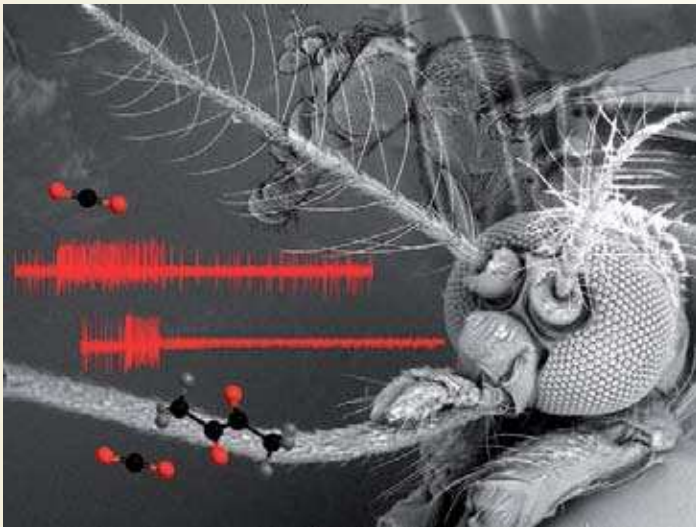
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to a star, orbiting it in the way the planets in the solar system orbit the Sun. This is the first time that so many planets have been found without any sign of a parent star. As yet, astronomers are not clear about where the free-floating planets come from. One option proposed by them is that they were formed in the same way as stars – by using gravity to suck up nearby material. Yet that process is unlikely to have formed so many small objects. It is also likely that the free-floaters started out in planetary systems but were ejected from orbit later, primarily due to interactions with other planets. Without a star to circle, these planets would move through the galaxy as our Sun and other stars do, in stable orbits around the Galaxy's centre.

Preventing mosquito bite by smell

Mosquitoes are among the most effective carriers of diseases. Every year malaria, dengue, yellow fever, and filariasis caused by pathogens transmitted by female mosquitoes cause several million deaths and hundreds of millions of cases. Several methods have been used to control mosquito populations, but with only limited success. Now a team led by Anandasankar Ray, an assistant professor of entomology at the University of California, USA, has come out with odour-producing chemicals that act to disable the mosquito's ability to find their target for biting (*Nature*, 2 June 2011 | doi:10.1038/nature10081).

It has been known that to find human hosts to bite and spread disease, female mosquitoes use exhaled carbon dioxide as a vital cue. Their CO₂ receptors are located on tiny, antennae-like appendages near their mouths. Once they encounter a CO₂ plume, they orient and fly upwind, eventually landing on their target. This propensity of the female mosquito is already being exploited in traps that use CO₂ for trapping mosquitoes, but these are expensive and



The CO₂ receptors in mosquitoes are located on tiny, antennae-like appendages near their mouths.

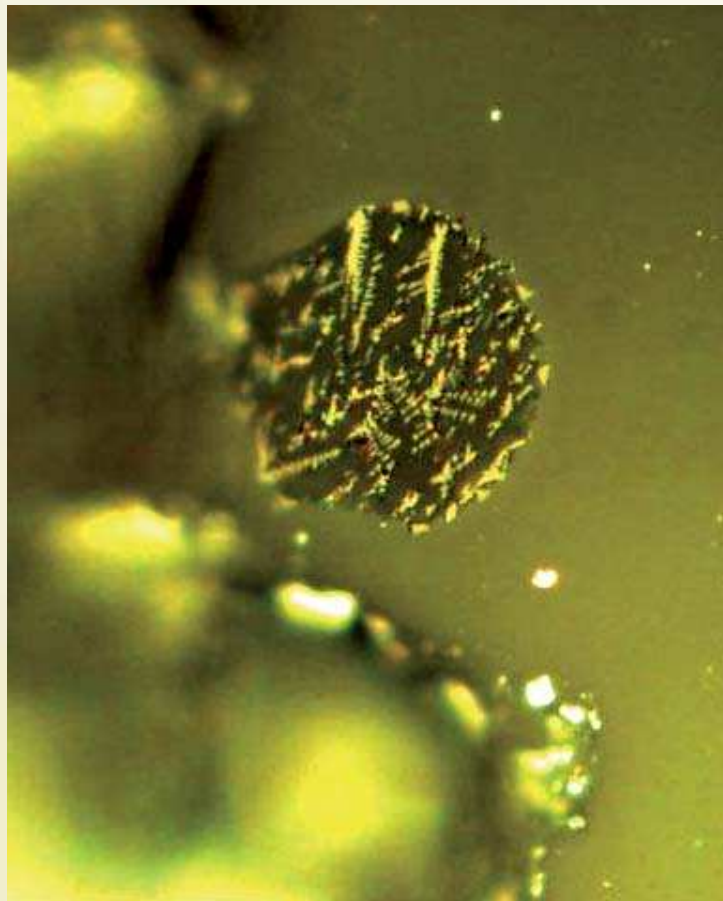
rarely used in developing countries, where mosquito-borne diseases kill millions. Ray and his team exploit the same CO₂-detecting machinery of the mosquito, but in a different way. They have identified three classes of compounds that give off smell that could keep the mosquitoes away by affecting the mosquitoes' carbon dioxide receptors. The smelly substance overwhelms the mosquito's CO₂-detection system and totally disorients them, preventing them from finding and biting human targets.

Ray and his team examined three species of disease-transmitting mosquitoes: *Anopheles gambiae* (for malaria), *Aedes aegypti* (for dengue and yellow fever), and *Culex quinquefasciatus* (for West Nile virus), which together infect half a billion people a year. The team also identified three classes of smell-producing chemicals that could keep the mosquitoes away. These included chemicals that could inhibit the CO₂ receptor in mosquitoes; chemicals that could mimic CO₂ and could be used as lures in traps to attract them away from humans; and chemicals that could bind with the receptors and cause ultra-prolonged activation of the CO₂-sensing neurons, effectively 'blinding'

the mosquitoes and disabling their CO₂ detection machinery for several minutes. One of binders tested was 2,3-butanedione, which is found in alcohol and added to buttery-flavoured food. Exposure to this chemical was found to strongly inhibit CO₂-sensitive neurons in the brain of in all the three mosquito species by overstimulation. The chemical led the mosquito's brain into thinking it is surrounded by huge quantities of gas, so it cannot decide where to go. By disabling the mosquito's guidance system, the researchers found a way of making them lose their way and unable to

find human targets. The team also tested the effectiveness of a blend of four chemicals containing 2,3-butanedione, 1-hexanol, 1-butanal, and 1-pentanal.

To test the effectiveness of their method, the researchers released female mosquitoes into a large greenhouse that contained two huts with CO₂-emitting traps in them. One of the huts also had some blended binders in a small fan-driven dispenser. Normally the mosquitoes should have moved directly towards the CO₂ traps in both the huts. But when the binder dispenser was turned on, only a few mosquitoes entered the CO₂ trap in this hut, clearly showing the disorienting effect of the binder chemical. According to the researchers, the results of the tests clearly show the possibility of developing new generations of insect repellents and lures using the three classes of CO₂-response-modifying odours, which even in small quantities can interfere with the ability of mosquitoes to seek humans.



A lunar melt inclusion from an Apollo 17 sample, enclosed within an olivine crystal. Melt inclusions show the highest concentration of water. (Credit: Thomas Weinreich/ Department of Geological Sciences, Brown University)

The Moon is wetter than earlier believed

One of the most significant discoveries of India's first Moon mission *Chandrayaan-1* was the widespread presence of water molecules in lunar soil. The discovery was made by the Moon Mineralogy Mapper – an instrument carried by *Chandrayaan-1*. Subsequently, the *Chandrayaan-1* data was corroborated by NASA's *Lunar Crater Observation and Sensing Satellite (LCROSS)* that crashed into a crater near the Moon's south pole in October 2009. The 9,000-km-per-hour impact carved out a hole 20 to 30 metres wide and kicked up some 100 litres of water. But further analysis indicated that the amount of water vapour and ice was more like 160 litres – an increase of 60%. A recent study of Apollo mission Moon rocks by researchers from Case Western Reserve University, Carnegie Institution for Science, and Brown University in USA has revealed that parts of the Moon's interior may contain as much water as the upper

mantle of the Earth – 100 times more than measured before (*Scienceexpress*, 26 May 2011 | 10.1126/science.1204626).

The scientists discovered water along with volatile elements in lunar magma trapped inside of crystals that are trapped inside tiny volcanic glass beads brought back to Earth by *Apollo 17* astronauts. The orange-coloured beads came from deep within the lunar interior during volcanic eruptions long ago when the Moon was still geologically active. The researchers used standard methods normally used to analyse rocks, to study the Moon rocks and found water contents of the trapped crystals to be up to 100 times higher than the water content of the glass matrix surrounding the crystals. In fact, the researchers found the concentrations of water and volatile elements including fluorine, chlorine and sulphur in lunar magma to be nearly identical to concentrations in solidified magma from primitive terrestrial mid-ocean ridges on Earth.

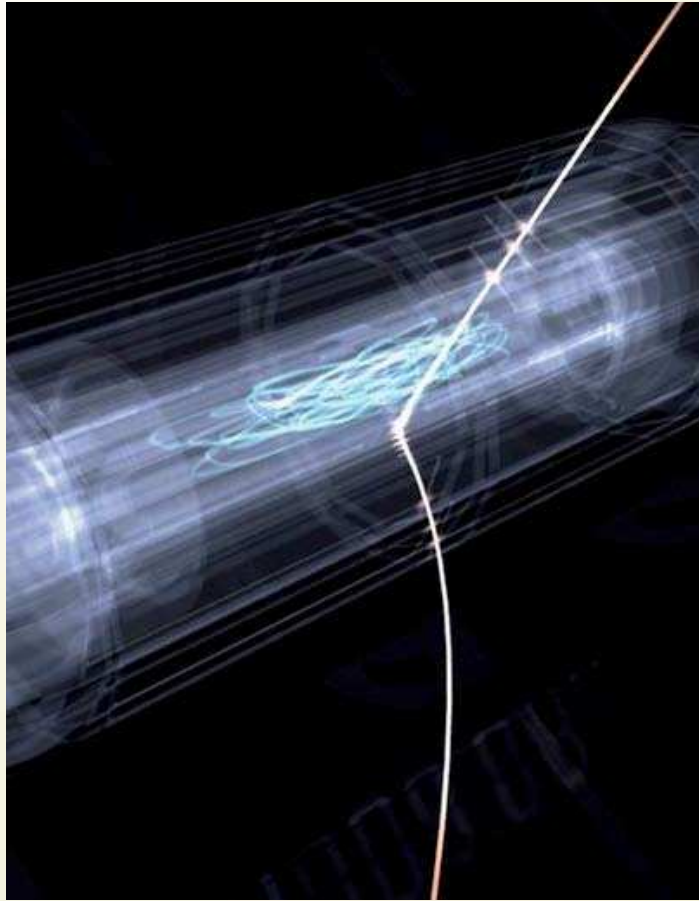
According to the researchers, the new findings will throw new light on the origin of water ice in the shadowed craters of the Moon, which were earlier attributed to cometary and meteoritic impacts. It is quite possible that part of this water came from lunar primitive magma during volcanic eruptions on the Moon.

Antimatter trapped for more than 15 minutes

Antimatter is matter consisting of elementary particles which are the antiparticles of those making up normal matter. But the study of antimatter has been impossible in the past because of the difficulty in storing it; the moment antimatter comes in contact with ordinary matter, both are annihilated and disappear with a burst of energy. But a recent success may make it possible for scientists to have a closer look at antimatter.

Just a few months ago, physicists at CERN, the European particle physics

laboratory near Geneva, had reported that they had trapped atoms made of antimatter for a fraction of a second (*DREAM 2047* February 2011). Now, the same team has held on to individual atoms of anti-hydrogen, each of which consists of an antiproton bound to a positron, for up to 16 minutes. That is considered long enough for an atom to lose all of its internal energy and settle into its least-energetic 'ground state,' which is necessary for studying it in detail. This may also allow physicists to



Artist's conception of an anti-hydrogen atom being released from the trap after 1,000 seconds. The twisting line represents the anti-atom's path in the trap while it is trapped. The curved tracks emerging represent the annihilation products (pions) resulting when the released anti-atom hits the inner wall of the trap.

precisely do a comparison between hydrogen and anti-hydrogen in the hope of finding a flaw in a key symmetry between matter and antimatter.

As in their previous work, researchers with the ALPHA experiment cooled a stream of antiprotons into a cloud of several thousand particles. The antiprotons were created in an accelerator by smashing high-energy protons into a stationary target. The

antiprotons were then slowed down and cooled in a series of steps involving a storage ring and electromagnetic traps. The team used an additional electric field to slosh the cloud of 15,000 antiprotons through the 1 million positrons chilled to 40 kelvin (-233°C), giving the particles a chance to form anti-hydrogen atoms. The positrons were produced by a radioactive source and then accumulated and cooled in a special trap. About once out of 10 times, an antiproton and a positron combined to make an anti-hydrogen atom, which is neutral. Uncharged atoms cannot be bound by an electric field, so the physicists used a magnetic field to grasp the few atoms that formed.

In November 2010, ALPHA researchers had reported that they had trapped anti-hydrogen atoms for 0.172 seconds. This time, they waited longer to turn off the magnetic trap, and in seven of 16 attempts, they held an atom for 1,000 seconds – that is more than 16 minutes. They even succeeded in one of three attempts to hold an atom for 2,000 seconds (*Nature Physics*, doi:10.1038/nphys2025). According to the researchers, that is enough time for an anti-hydrogen atom to lose its internal energy and reach its ground state. However, still the efficiency of trapping is considered low – for each anti-atom confined by the trap, thousands more from the same batch escape.

Nonetheless, once anti-hydrogen atoms are available in the ground state it should be possible to measure the arrangement of internal states in anti-hydrogen and compare it with that in hydrogen, which is known to a precision of one part in 10^{14} . Any difference would violate symmetry between matter and antimatter known as charge parity time (CPT) reversal symmetry, which requires, for example, a particle and its antiparticle to have the same mass and lifetime. And if CPT symmetry does not quite hold, then neither can symmetry of space and time called Lorentz invariance, which is the basis for Einstein's theory of special relativity. There lies the significance of the recent success. ■

National Workshop on Science Broadcasting

Vigyan Prasar has been supporting the production of many radio and television programmes on scientific topics in different Indian languages. Still, the coverage of science in Indian television and radio channels is very low. To facilitate the production science programmes by broadcast channels, there was a need for capacity building among TV and radio producers to deal with complex and abstract concepts in science and to inculcate in them the best practices in creating interesting programmes on science, technology, health, agriculture, and environment.

Vigyan Prasar in collaboration with *Surabhi Serva Shiksha evam Kalyan Samiti* (SEVAKS), New Delhi, organised a National Workshop on Science Broadcasting from 2 to 6 of May 2011 at Indian Institute of Mass Communication in New Delhi.

Inaugurating the workshop, Er Anuj Sinha, Director, Vigyan Prasar, called upon the participants to become effective science communicators. He said, community radio, web media, Pod Casts, MP3 Downloads, radio, and television are the new arenas that need to be exploited in addition to the print medium. He emphasised that a good journalist will often play the role of a researcher, writer, director and/or editor and must work on different skill sets to be effective.

Prof Devesh Kishore, Professor Emeritus, MLC National University of Communication & Journalism, Bhopal, was the keynote speaker. He stressed the need to know the audiences and their information/communication needs before planning for programmes – 'feed-forward' research that informs the producers of the appropriate pace and style of the content.

In his welcome address, Maj. Somesh C. Jhingan, Registrar, Vigyan Prasar said through this workshop Vigyan Prasar is creating a platform for building up synergy by identifying and joining with other players and forging new relationship so that the message of science can be spread widely. He said this can be done only through a cascading



Er Anuj Sinha, Director Vigyan Prasar, encouraging the participants to become effective science communicators

effect by first identifying the trainers and subsequently training the trainers to ensure optimal utilisation of the most forceful and impactful source(s) of broadcasting.

Prof Hemant Joshi of IIMC in his opening remarks said that the issue today is not so much of making good quality programmes on science and technology, or to market them for proper slots. The main issue is of getting the eyes and ears of people and grab their attention and create a long lasting interest in them not only about science and technology but for knowledge at large. He said we should not look at science and technology as specialised fields and communicating about them as yet another specialised field. We must try to inculcate our expertise in more and more people so

that instead of creating a distance between classes and masses, instead of making science and technology in particular and knowledge in general as mystic disciplines, we must demystify them. The task is challenging, as most knowledge and science is abstraction and masses have the habit of living in concrete real world.

The book titled *Broadcasting Science*, published by UNESCO and AIBD for the specific purpose of training TV and radio producers, was the foundation for the workshop activities. The author of the book Mr K. P. Madhu was the lead trainer. The workshop also had guest lectures by Mr

Sandeep Nigam, Senior Producer & Science Broadcaster, Star News; Mr Gauhar Raza, Head, Science Communication through Multi-Media, National Institute of Science Communication and Information Resources; Prof Hemant Joshi, Associate Professor, IIMC, New Delhi, and Dr C. M. Nautiyal, Scientist-in-Charge, Radiocarbon Lab & Science Communicator, BSIP, Lucknow. Dr Subodh Mohanti, Dr T. V. Venkateswaran, and Mr Nimish Kapoor from Vigyan Prasar also addressed the participants. There were 15 participants - from Tamil Nadu, Karnataka, Maharashtra, Orissa, Bengal, Uttar Pradesh, and Delhi. The participants consisted of three community radio professionals, three professionals producing for AIR, two TV producers, three academics teaching



Workshop in progress

journalism, an academic who is setting up a community radio, two from national science laboratories, and a young person keenly interested in science communication.

The feedback from the workshop was quite encouraging. The responses from the participants indicated that it was highly useful for radio and television producers. The skills and knowledge acquired during the workshop would be put to use in their day-to-day work by most of the participants.

The National Workshop was held in Delhi as a pilot project to evaluate the need for such training of TV and radio producers and to assess the impact of such trainings on the quality and quantity of science coverage in India. Given the success of the National Workshop on Science Broadcasting, Vigyan Prasar will organise regional workshops in different parts of the country.

Interaction of resource persons with broadcasters during technical sessions

Master Resource Person of the workshop Mr K P Madhu focussed on the skills needed to

do quick and efficient research on scientific topics, the ways in which complex scientific content is broken down to simpler elements and the ways in which information is imbued with emotions and the facts presented flow like a story. Many useful tips, tricks and tools were demonstrated and the participants were given time to practise some of them.

Scientist and Film Maker Mr Gauhar Raza spoke on the development scientific ideas and importance of asking questions. He emphasised that the meta question that science asks begins with 'How' whereas other structures of configuring cosmic reality ask and seek answers to questions which begin with 'why'. Therefore science is an open ended knowledge system whereas all other system including 'religions' are closed system. Science does not have final answer and every answer in science leads to new questions. He also emphasised that in science latest information and theories are considered more authentic whereas in other systems older scriptures are considered more authentic it is. He covered the journey on knowledge development from flat earth as

the centre of universe to big bang theory.

Scientist and science communicator Dr C. M. Nautiyal spoke on 'Bridging Scientists and Science-communicators'. He quoted Asimov's caution that a public that does not understand how science works can, all too easily fall prey to the ignoramuses. So the public outreach using various media is essential. This means what is done by the scientists and technologists must reach the common man. He quoted his own research on the subject that concluded that majority of the scientists surveyed by him believes that scientists should communicate to public. Media should also take an initiative. But before talking to a scientist, the broadcaster should be clear as to the purpose and also let the scientist know. Clarity about the target and the overall purpose (information, education, entertainment, welfare, inspiration or change in the attitude or habit?) is essential. Without that, one cannot expect to get meaningful material from the scientist who is used to talking to the specialist from purely academic angle.



SITTING: Kinkini Dasgupta Misra, Dr T.V. Venkateswaran, K.P. Madhu, Er Anuj Sinha, Dr Hemant Joshi, Maj Somesh Jhingan, Dr C.M. Nautiyal
MIDDLE ROW: Ajai Chawla, Nimish Kapoor, Wafia S. Masih, Mausumi Bhattacharyya, Arpna Chandail, Amit Kumar, T. Sripath, Siddhartha
TOP ROW: J. Jaganpradeep, Abhishek Jain, Rahul R. Kasture, Abhay S.D. Rajput, Romesh Chaturvedi, Mobin Khan, Aseem Mathur, Manas R. Das

Prof Hemant Joshi spoke on scientific temper, critical thinking, attitudes and language of science and broadcasting. He said that science broadcasters cannot always make programmes about science and technology...they can use broadcasting to remove general ignorance and build a

scientific attitude in masses which may later help them to communicate higher level science and technology. School and college going youth believe in many kinds of superstitions. During their exam they go to temples, dargahs, church, etc., no so much with religious reasons but to pray that

they do well in their exams and to ask God to make things easier for them. Those who don't go there or whose wishes are not heard by the Almighty sometime commit suicide as they do not have anyone else to help them. Getting connected to such people through broadcasting could do wonders. ■

Regional workshop on Innovative Experiments in Physics



Dr. M. S. Marwah demonstrating experiments

Vigyan Prasar has planned five regional workshops on Innovative Experiments in Physics, based on the module developed by Vigyan Prasar and IIT, Kanpur as a collaborative programme to train Master Resource persons. The third four-day workshop was organised for the Central Zone at Bhopal, from 4 to 7 May 2011. Fifty teachers and science communicators attended the workshop. The participants of this workshop were selected out of 300 nominations received by VP. The nominations were invited through Dream-2047, VIPNET News and Vigyan Prasar website.

The workshop was inaugurated by Shri Ajit Shrivastava, Executive Director, Madhya Pradesh Council for Science and Technology, Bhopal. Dr. V. B. Kamble, former Director, Vigyan Prasar was the chief guest at the inaugural function.

Shri Rintu Nath, Scientist E, VP; Dr. Mukesh Rai, Associate professor, IIT Jabalpur; and Dr. M. S. Marwah, Associate professor, Sri Guru Gobind College, Chandigarh;

conducted the workshop and demonstrated 140 innovative activities/experiments during the four days. Participants did hands-on activities during the workshop. Each participant assembled one kit. Using the kit about 20 activities can be performed. A CD on 'Innovative Experiments in Physics' and a

kit 'Emergence of Modern Physics' developed by VP was given to all the participants. Shri B. K. Tyagi, Scientist D, VP, interacted with the participants and briefed them about how science clubs can be formed and registration can be done with Vigyan Prasar.

Dr. V. B. Kamble gave a talk on emergence of modern physics. Dr. Kamble and Shri Rintu Nath demonstrated the 'Modern Physics Kit'. Shri Rintu Nath performed a few experiments based on the PC interface developed by Vigyan Prasar and explained how new projects can be designed using the kit.

The valedictory function on 7 May 2011 was presided by Professor P. K. Verma, Director General, Madhya Pradesh Council for Science and Technology. Professor Verma addressed the participants and said that MPCST would take forward the efforts of Vigyan Prasar on a sustainable basis. He assured that all possible help will be extended to the participants to disseminate innovative activities throughout the state and adjacent states. All the participants were given a certificate of participation by Professor Verma. ■



Valedictory function: (from left) Dr. M. S. Marwah, Prof. K. I. Vasu, Prof. P. K. Verma, and Shri Rintu Nath