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A bright revolution

Nobel Prize in Physics 2014



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<i>Editorial: Useful leads on disasters-related communication strategies</i>	35
A bright revolution	34
Metal poisoning	32
Phytopharmaceuticals and their health benefits	30
Numbers we need to keep in our memory	27
Glaucoma—Risk Factors, Diagnosis and Self-help	24
Recent developments in science and technology	21

Useful leads on disasters-related communication strategies



Dr. R. Gopichandran

The objective of the present editorial is to present information on some recent excellent publications/insights about communication with respect to disasters. The cited publications dwell on the dynamics of preparedness of receivers of information and appropriateness of tools for optimal delivery of messages. The Capstone Project¹ emphasises a two-way communication strategy duly recognising the milieu of trust between local media and aid organisations. The success of communication strategies appears to be a function of financial resources available and the type of emergencies. Disaster relief programmes provide the context for communication systems and networks. Local media are expected to establish accountability and transparency of relief efforts, communicate solutions and dispel wrong understanding of choices.

The EU² has taken stock of its progress with respect to the Hyogo Framework and calls for policy support for exchange of insights on experiences to improve governance for risk management. This includes mainstreaming good practices with implications for improved communication with stakeholders. Interestingly the Federal Emergency Management Agency of the United States of America³ has emphasised amateur radio as a robust tool for communication during emergencies. This is based on a track record of “inventiveness & service” approach of operators who have consistently delivered during emergencies at the local level.

A classic publication by the Centres for Disease Control & Prevention of the United States Department of Health and Human Services⁴ highlights many and cross-cutting challenges in communication on health related aspects. The communication life cycle and the processes by which people internalise messages are presented with a special emphasis on the mental states of the affected. Crisis communication plans and step-by-step guidance on media communication strategies are

also discussed with valuable leads that can be suitably adapted for specific circumstances. It is essential to however recognise that post-disaster relief and rehabilitation efforts are unique segments of impacts mitigation. Cultural affinities/preferences of communities, location, intensity, source of perturbations and political will to enable access to mitigation and adaptation options in a timely manner are equally important determinants of success of these strategies.

1. Communicating During Disasters: Examining the Relationship between Humanitarian Organizations and Local Media. 2013. The Capstone Project commissioned by Internews www.internews.org in collaboration with Columbia University’s School of International and Public Affairs (SIPA). Erina Aoyama et al. 17p. https://internews.org/sites/default/files/resources/Internews_SIPA_communicating_disastes_2013-09.pdf
2. European Commission Brussels, 8.4.2014 COM(2014) 216 final Communication from the Commission to the European Parliament, The Council, The European Economic & Social Committee and the Committee of the Regions. The post 2015 Hyogo Framework for Action: Managing risks to achieve resilience. 12p. http://ec.europa.eu/echo/files/news/post_hyogo_managing_risks_en.pdf
3. FEMA & ARRL Announce Disaster Communication Partnership. Release date: July 18, 2014 Release Number: HQ-2014-51 2p. http://www.severe-weather.org/FEMA-ARRL_MOU.pdf
4. Crisis Emergency Risk Communication. Be First. Be Right. Be Credible. 127p. http://emergency.cdc.gov/cerc/resources/pdf/cerc_2014edition.pdf

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A bright revolution



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The Nobel Prize in Physics 2014 was awarded jointly to Isamu Akasaki, Hiroshi Amano and Shuji Nakamura “for the invention of efficient blue light-emitting diodes which has enabled bright and energy-saving white light sources”. The following article is an effort to tell our readers how the invention took place and the significance of the invention.

Incidentally, the United Nations proclaimed the year 2015 as the International Year of Light and Light-based Technologies to recognise the importance of light and light-based technologies in the lives of the citizens of the world, and for the future development of global society on many levels.



1,00,000 hours. On the other hand, incandescent lamps lasts for 1,000 hours and fluorescent lamps lasts for 10,000 hours.

How LEDs produce light

In an LED, when an electron recombines with a hole, energy is released in the form of visible light (photon). Colour of the emitted photon in an LED is dependent on energy produced during recombination. Within the visible range of electromagnetic spectrum, red light photon has the least energy and blue has the highest energy. During the initial development period (1950), researchers could manufacture LEDs that could produce energy corresponding to red light. During subsequent years manufacturing techniques improved and assembly lines were set-up for bulk production of red LEDs. During 1960s red LEDs became common in producing illuminated patterns and used in a number of electronic devices and circuits. Now scientists wanted to produce LEDs that could produce different colours.

It was known that different types of semiconductor materials produce different recombination energies. Scientists started experimenting with different combinations of semiconductor materials that could produce higher recombination energy than the energy required for red light. Manufacturing techniques also improved. Researchers wanted to develop green and

For a long time scientists had believed that light emitting diodes (LEDs) can never be used as source of light for general lighting and that their usage would be limited to ornamental lighting and display devices like televisions, mobile phones and similar gadgets. The belief was due to difficulty in producing blue light-emitting diodes, one of the key constituents necessary to produce white light from LEDs.

Red and green light-emitting diodes have been in use for over half a century, but blue light was needed to really revolutionise lighting technology. Only the triad of red, green and blue can produce white light that can be used for general illumination. Despite intensive research undertaken by scientists, blue light-emitting LED remained a challenge for three decades.

LEDs produce light directly from electrical energy without any intermediate stage. As a result, LEDs are far more energy-efficient compared to other sources of artificial light, where only a fraction of total electrical energy is converted to light. In case of incandescent lamps, electrical energy is first converted to heat energy and the heated filament subsequently emits light. In case of a fluorescent tube or CFL, electrical energy is first used to ionise

a gas and subsequently produce light by fluorescence of a phosphor coated on the inside of the tube. In the absence of any intermediate stage, LEDs require lesser energy to emit light compared to other light sources. Moreover LED technology is constantly improving to produce higher luminous flux (measured in lumens) per unit of electrical energy. For example,



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LEDs can produce 300 lumens per watt of electrical energy compared to 16 lumens for regular incandescent lamps and 70 lumens for fluorescent lamps. As about one-fourth of world electricity consumption is used for lighting purposes, so the highly energy-efficient LEDs can contribute to substantial saving of Earth's resources.

LEDs are also long lasting. On an average, an LED lamp can last for over

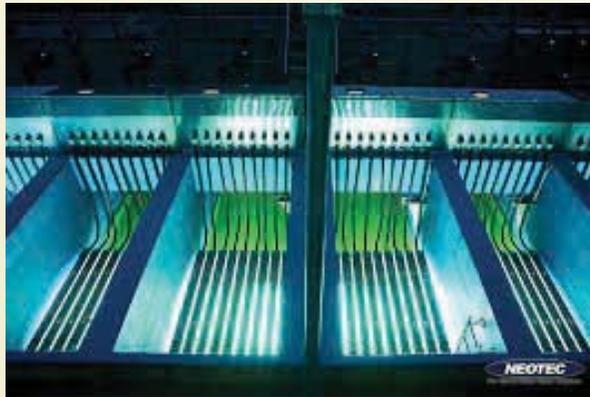
blue LEDs. It was realised that in order to use LED as a source of light for household application, white light would be required. But white light could be generated only by a combination of red, green and blue LEDs, and green and blue light-emitting LEDs were still not around.

After almost a decade of intensive research scientists could produce LEDs that emitted green light. Use of green LEDs,

along with red LEDs were limited to use as indicator or display as in calculators, digital clocks, etc. Scientists wondered if it would ever be possible to increase the energy of LEDs to such an extent that it could be used as source of light in place of incandescent or fluorescent lamps. If it were possible, scientists knew, it would bring about a revolution in terms of electricity consumption globally.

Challenges

Researchers around the world could realise the immense benefit that LEDs can bring to mankind if they could produce a blue light-emitting diode. Recombination energy required to produce blue light is higher than that needed for green light. Researchers tried with different combinations of materials



UV disinfection tank. Source: NEOTEC UV Inc. (2012)

and different manufacturing techniques. However, despite repeated efforts by scientists around the world, blue LED remained elusive for a decade. It was in generally felt that blue light-emitting diode may be impossible to manufacture.

But there were many who did not give up and decided to take up the challenge. While working as a professor at Nagoya University, Isamu Akasaki and a PhD student Hiroshi Amano from the same university built specialised equipment in order to carry out experiments with different manufacturing techniques. Most of the time they failed, but only to start again, with new determination. Ultimately they selected a compound known as gallium nitride to make blue LED.

Earlier also scientists used gallium nitride to produce blue light, but the problem was that growing high-quality gallium nitride crystals was very difficult. It was a challenging endeavour to try to

produce a fitting surface to grow the gallium nitride crystals on. Moreover, it was virtually impossible to create p-type layers in this material. Nonetheless, Akasaki was convinced from previous experience that the choice of material was correct, and continued working with Amano.

Nakamura began developing his blue LED in 1988 while working in a small company named Nichia Chemicals in Japan. He also chose gallium nitride as a potential compound for creating blue LEDs.

Breakthrough

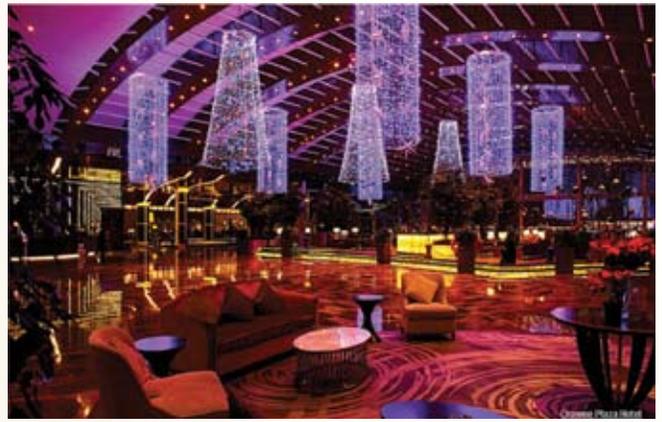
Akasaki and Amano finally succeeded in creating a high-quality gallium nitride crystal. They placed a layer of aluminium nitride on a sapphire substrate and then grew high-quality gallium nitride on top of it. In 1980 they made a breakthrough in creating a p-type layer. In 1992 they were able to present their first diode emitting a bright blue light.

Nakamura also succeeded in creating high-quality gallium nitride two years after the success of Akasaki and Amano. However, Nakamura's solutions were different from those of Akasaki and Amano.

During the 1990s, both research groups succeeded in further improving their blue LEDs, making them more efficient. They created different gallium nitride alloys



LED headlight of a car



LED illumination

using aluminium or indium, which made the structure of the LEDs increasingly complex.

Akasaki, Amano and Nakamura also invented the blue laser in which blue LED is an integral part. As frequency of blue light is higher than that of red light, more information can be stored and transmitted using blue laser. That is why Blue-ray discs can store more data compared to conventional compact discs.

Way ahead - a bright future

The inventions of Akasaki, Amano and Nakamura revolutionised the field of lighting technology. New, more efficient, cheaper and smarter lamps are now being built using LEDs. LED lamps are flexible light sources whose colour and intensity can be varied as per requirement. It is possible to control brightness and colour of LEDs using a computer. Computer controlled LEDs will be the future of all forms of lighting technology. Greenhouse-cultivation using LED is already a reality. The LED lamp also holds great promise when it comes to the possibility of increasing the quality of life for the more than 1.5 billion people who currently lack access to electricity grids. Low power requirements imply that LEDs can be effectively powered by solar panels. Contaminated water can be sterilised using ultraviolet-emitting LEDs, a subsequent elaboration of the blue LED.

The invention of the efficient blue LED is just twenty years old, but it has already contributed significantly to the benefit of us all. All this was made possible only by the tireless and sincere efforts of a band of dedicated scientists including Akasaki, Amano and Nakamura. ■

Metal poisoning



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Environmental pollution is one of the severe problems worlds facing today. Trace metals are major environmental pollutant, which are discharged into the atmosphere from the burning of fossil fuels, release of industrial wastes and use of agrochemicals. Toxic metals such as mercury, cadmium, chromium, arsenic, copper, lead, etc. tend to accumulate in bottom sediments of water bodies from which they may be released and can move up the biologic chain, and reach humans. Increasing contamination of air, water, soil and food by heavy metals has become a threat to the continuous existence of countless species of plants and animals and also the human race. Bioaccumulation (accumulation in organic tissue) of toxic metals in the food chain can be highly dangerous to human health due to their persistent nature and potential toxicity. Metals enter the human body through inhalation and ingestion, with ingestion being the main route. Other terms such as 'trace inorganics', 'heavy metals', 'micro-nutrients' and 'micro-elements' are being treated as synonymous with the term 'trace metals'.

Sources of metal pollution

Natural sources

Natural metal enrichments in solid substances can originate from weathering of rocks or rock debris from the river bed, particles, precipitation products and adsorbed substances formed due to physicochemical changes in the water, biologic remains, decomposition products of organicsubstances as well as inorganic siliceous or calcareous shells, metal enrichment resulting from atmospheric fallout and particles coming from space. Many of the metallic ferrous deposits containing ores of copper, lead and zinc are generally associated with igneous rocks of acid to intermediate composition. Rocks known as pegmatitic granite are the home of several minerals containing rubidium, lithium, beryllium, cerium, yttrium, tantalum, etc. Trace metals increase with the transition from granite to shale. Compared to shale, the trace metal content in sandstone is much less. Weathering of arsenic-rich sulphides such as pyrite releases bivalent Fe, which readily forms amorphous oxyhydroxides in an oxidising environment

that would strongly absorb or adsorb co-weathered arsenic. Several isolated geological sources for arsenic have been recognised, viz., Gondwana coal seams in Rajmahal basin (200 mg/kg of As), Bihar mica-belt (0.08-0.12% of As), pyrite-bearing shale from the Proterozoic Vindhya range (0.26% of As), Son valley gold belt (2.8% of As), and Darjeeling Himalayas belt (0.8% of As). Geothermal sources, such as volcanic eruptions also cause significant mercury pollution of the atmosphere.

Anthropogenic Sources

The serious effects of mine effluents on the water quality in river and lakes, as well as on the biotopes (small areas with a particular distinct ecology) have been known for many years. Mines of coal, gold, silver, copper, tin, etc., contain various toxic metals and cause severe water pollution. Metal levels in soils and river sediments are high near the treatment plant and also in natural vegetation growing over the ore deposits. Industrial effluents are another anthropogenic (human created) source of heavy metal pollution. Petroleum refining, steel and fertiliser production, etc., are a major contributor of cadmium, chromium copper and iron pollution. The principal source of chromium is discharges of industries using large amounts of chromates, as in the textile industry, leather tanning industry and in industrial dyes.

Commercial forest, grassland and cultivated agricultural areas are potentially large contributors of nonpoint sources of heavy metal pollution. Soil may become enriched with hazardous heavy metals due to application of plant nutrients and crop protective measures. Phosphatic fertilisers often contain high levels of trace elements, especially cadmium. The use of herbicides or grass control also causes metal pollution. An arsenical herbicide called monosodium methanearsonate (MSMA) contains arsenic.

Sewage sludge, which contains trace elements with toxic properties, is often used as a plant nutrient source on cultivated soils. Coal-fired electric power plants are potential sources of metal pollution. Average concentration of arsenic in Indian coal ranges up to 3.72 mg/kg, with a maximum value of 40 mg/kg (Sohagpur coalfield, Northeastern India). Hence, it is believed that coal

combustion is one of the major sources of anthropogenic emission of metals in the environment. There are several metallurgical plants, cement factories, incineration and chemical industries contributing to the emission of arsenic, mercury, cadmium, selenium, zinc and lead into the environment. Cadmium, selenium and arsenic are emitted in appreciable quantities by the combustion of coal and cement production, whereas oil-burning is responsible for emission of nickel, vanadium and mercury into the atmosphere.

The treatment of potato seeds with mercurial solution to control latent diseases and rots causes mercury pollution. The use of detergents also creates a possible pollution hazard. Most enzyme detergents contained trace amounts of Fe, Mn, Cr, Ni, Co, Zn, Sr and B. All the widely used soaps/detergents contain high arsenic concentration ($\mu\text{g/l}$ or ppb) in soluble form. For example, Lux (6.0 ppb), Hamam (6.5), Pears (1.5), Rin (10.0), Surf excel (5.5), Vim (7.0), Cinthol (7.0), Mysore sandal (6.0), etc. All these soaps and detergents readily release arsenic when used, which reach surface and groundwater.

Health hazard due to trace metals

Although arsenic is widespread in plant and animal tissues, it has become synonymous with 'poison' in the public mind. Arsenite (any salt of arsenious acid) inhibits thiol-dependent enzymes and binds to tissue protein as keratin disulphides in hair, nails and skin and is retained in the body for a prolonged period. Long-term ingestion of arsenic-contaminated drinking water produces gastro-intestinal, skin, liver and nerve tissue injuries. Trivalent arsenic (arsenite) is 60 times more toxic to human beings than the pentavalent arsenic (arsenate). The most commonly observed symptoms of chronic arsenic poisoning are skin cancer, conjunctivitis, melanosis (abnormal deposits of melanin) and hyperkeratosis (abnormal thickening of the skin). Consumption of excess quantity of arsenic has been reported

to cause damages to kidneys and lead to, neurological, hepatic, haematological and respiratory disorders and even cause cancer. The desirable limit prescribed by ISI (Indian Standard Institution) and WHO (World Health Organization) for arsenic is 0.01 mg/l in drinking water.

Chromium is one of the least toxic of the trace metals. The mammalian body can tolerate 100-200 times its total body content of Cr without any harmful effects. Chromium (VI) is approximately 100 times more toxic than Cr (III). According to WHO, 0.05 mg/l of total Cr in drinking water is unlikely to cause significant health risks. Mercury is a nonessential but highly toxic element for living organisms. Poisoning by methylmercury compounds presents a bizarre neurological picture as observed in large scale outbreaks in Japan and Iraq. The "Minamata disease" in Japan was caused by the consumption of mercury-contaminated fish caught by fishermen and their families from Minamata Bay in Japan. The patients who had consumed the contaminated fish and shellfish progressively suffered from a weakening of muscles, loss of vision, impairment of cerebral functions and eventual paralysis, which in numerous cases resulted in coma and death.

Cadmium is an environmental pollutant ranked eighth in the top 20 hazardous substances priority list. It is a nonessential element for humans and can cause various acute and chronic adverse effects, such as renal, nervous, and bone diseases and is identified as carcinogenic to humans. During 1947 an unusual and painful disease called 'itai-itai' disease was recorded in the case of 44 patients from villages on the bank of the Jintsu River of Japan. The most characteristic features of disease were lumbar pains and pain in leg muscles. Damage to kidneys led to excretion of large amounts of albumin in urine. The incubation period for chronic cadmium intoxication varies between five and ten years, but in some cases it may be as long as thirty years. During the first phase of poisoning a yellow discoloration of the teeth ("cadmium ring") is formed, the sense of smell is lost and the mouth becomes dry. The recommended limit for Cd in drinking water, prescribed by WHO, is 0.003 mg/l.

Zinc is one of the most abundant essential trace elements in the human body. The metabolism of humans, especially of

children and patients already suffering from irregular metabolism, may be affected. The taste threshold for zinc in drinking water is approximately 15 mg/l. The permissible limit as per ISI standards for Zn is 1.5 mg/l in drinking water.

Although lead is a nonessential element, it is present in all tissues and organs of mammals. Lead is a possible human carcinogen. The disease known as 'plumbism' is caused by acute lead poisoning. High blood lead levels can affect the kidneys and cause convulsion, coma or even death. Lead poisoning in childhood results mainly from the ingestion of lead-based paint or plasters or objects saturated or coated with lead-based paint and from ingested lead-containing soil. A chip of paint (the size of an adult's thumbnail) contains between 50 to 100 mg of lead. Acute lead poisoning is characterised by vomiting, colic, bloody diarrhoea, insomnia and other central nervous system problems, irritability, convulsions and death. One of the most common consequences of long-term lead poisoning is chronic kidney infection, known as 'nephritis'. The permissible limit of WHO for lead is 0.01 mg/l in drinking water.

Manganese is a known mutagen (can cause genetic mutation). The chronic ingestion of Mn in drinking water is associated with neurologic damage. The ISI recommended limit for Mn in drinking water is 0.5 mg/l. Beryllium is permanently retained in mammalian tissues. Beryllium is toxic due to its high retention, leading to inflammation of lungs, and heart disease in humans. Excess of copper in drinking water gives unpleasant and astringent taste. Iron is the most abundant transition element and well-known metal in biologic systems. The primary concern about Fe in drinking water is its objectionable taste and foul odour as a result of H₂S production. The permissible limit of iron in drinking water according to ISI standard is 0.03 mg/l.

Role of metal ions

The role of metal ions in living systems follows the pattern of natural availability and abundance of the metals in nature. No organic life can develop and survive without the participation of metal ions. It is well known that the major ions such as sodium, potassium, magnesium and calcium are essential to sustain biologic life. Few transition metals are essential for

optimal human growth, development, and reproduction. For example, manganese is involved in glucose utilisation. Iron is needed to prepare a protein called haemoglobin – the oxygen-carrying molecule of blood. It is regarded as the most important iron (II) complex consisting of the globin protein. The human body requires vitamin B₁₂, (to form haemoglobin) which is a cobalt (III) complex. Cobalt (II) is an enzyme activator. Copper (I) is found in enzymes capable of carrying oxygen as haemoglobin does.

Thus, it may be concluded that certain metals in trace amounts (smaller than 0.01% of the mass of the organism) are essential for an organism fails to grow or complete its life cycle. An undersupply of trace metals leads to a deficiency while sufficient supply results in optimum conditions, but an oversupply can lead to toxic effects and lethality in the end. Thus, all metals essential to life are toxic if ingested in concentrations in excess of the optimum concentration levels. Dietary supplementation of essential nutrients such as calcium, selenium or zinc may reduce the lethal effects of heavy metals. Diet rich in protein and vitamin C have been shown to have a protective effect against copper toxicity. Pure water and nutritious foods are the best medicines for getting cured from arsenic poisoning. Vegetable like carrots, seeds of jackfruit and soybean are recommended foods to fighting against arsenic toxicity.

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Phytopharmaceuticals and their health benefits



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Food plays a vital role in maintaining normal function of the human body. With recent advances in medical and nutrition sciences, natural products and health-promoting foods have received extensive attention from both health professionals and the common population. It is normally assumed that keeping proper nutrient balance is necessary to maintain good health, and that excess intake of any nutrient may not benefit or even can be harmful to health.

Phytonutrients or phytopharmaceuticals are more recent terms that refer to a group of natural substances that include certain herbs and such products of plant origin that are used as dietary supplements. Some of the important phytopharmaceuticals are anthocyanidins, carotenoids, lycopenes, flavonoids, glucosinolates, isoflavonoids, limonoids, polyphenols, omega-3 fatty acids, phytoestrogens, resveratrol, phytosterols, probiotics and terpenoids. They have specific pharmacological effects in human health. Many of these substances have anti-inflammatory, anti-allergic, antioxidant, antimicrobial, antispasmodic, anti-ageing, antidiabetic, and many other therapeutic effects.

Phytopharmaceuticals can be added to or enhanced in traditional foods through genetic engineering. An example would be the high-lycopene tomato, a genetically modified tomato with delayed ripening characteristics that is high in lycopene which has potent antioxidant capabilities.

Anthocyanins

Anthocyanins are the largest group of water-soluble pigments in the plant kingdom. They have been demonstrated to have potential health benefits and disease prevention properties and are known as potential antioxidants. Consumption of anthocyanin-enriched foods is associated with a reduced risk of several diseases such as atherosclerosis, dyslipidemia and diabetes. Anthocyanins

occur in all tissues of higher plants, including leaves, stems, roots, flowers and fruits. Plants rich in anthocyanins are *Vaccinium* species, such as blueberry, cranberry, blackberry, cherry, and red cabbage. The highest recorded amount is in the seed coat of black soybean. They are approved for use as a food additive in the European Union, Australia and New Zealand. The main anthocyanin compounds are pelargonidin, cyanidin, and delphinidin. Cyanidin and its glycosides are natural dietary pigments which have been found to have promising potential benefits to humans, especially in the prevention and treatment of diabetes mellitus.

Carotenoids

The group of carotenoids consist more than 700 phytochemicals found in photosynthetic membranes and produce colours in plants



and animals. Out of 700 pigments, only about 24 commonly occur in human foodstuff. The most-studied carotenoids are α -carotene, β -carotene, lycopene, lutein, and zeaxanthin. The principal carotenoids of foods are β -carotene, β -cryptoxanthin, lycopene, and lutein.

The β -carotene and lycopene have been shown to be inversely related to the risk of cardiovascular diseases, and certain cancers whereas lutein and zeaxanthin to eye disorders. Lutein protects against uterine, prostate, breast, colorectal and lung cancers. They may also protect against risk of digestive tract cancer. The antioxidant properties of

carotenoids have been suggested as being the main mechanism by which they afford their beneficial effects.

Lycopene

Lycopene, a carotenoid without provitamin-A activity, is present in many fruits and vegetables. Dietary intakes of tomatoes and tomato products containing lycopene is associated with decreased risk of chronic diseases such as cancer and cardiovascular diseases. Serum and tissue lycopene levels have also been inversely related with the chronic disease risk.

Flavonoids

Flavonoids are polyphenolic compounds present in berries, legumes, tea, grapes, olive oil, cocoa, walnuts, peanuts, spices, fruits, and green vegetables, onion, apple, berries and tea. Flavonoids have antibacterial, antioxidant, antiviral, and analgesic properties.

Flavonoids are a subclass of plant phenols which includes the minor flavonoids (flavanones and dihydroflavonols), flavones and flavonols. Flavonols are the most ubiquitous flavonoids in the foods. Quercetin and kaempferol are the main representatives of this group. They are generally present at relatively low concentrations of about 15-30 mg/kg fresh weight. Onions, leeks, broccoli, and blueberries are rich sources of flavonols. Flavanones are found in tomatoes and certain aromatic plants such as mint (*Mentha piperita*), but they are present in high concentrations only in citrus fruits. The main flavanones are naringenin in grapefruit, hesperetin in oranges, and eriodictyol in lemons.

Flavonoids are active against free radicals; free radical mediated cellular signalling, inflammation, allergies, platelet aggregation, microbes, ulcers, viruses, tumours and hepatotoxins.

Isoflavonoids

Isoflavonoids are another subclass of the phenolic phytonutrients. Isoflavonoids are produced almost exclusively by the members of the Fabaceae (Leguminosae) family. Their main sources are soy cheese, soy flour, soy bean and tofu. Soybeans are an unusually concentrated source of isoflavones, including genistein and daidzein, and soy is a major source of dietary isoflavones. The isoflavones of soy have received considerable attention owing to their binding to the estrogen receptor class of compounds, thus, representing an activity of a number of phytochemicals termed as phytoestrogens. Genistein inhibits the growth of most hormone-dependent and independent cancer cells *in vitro*, including colonic cancer cells. Isoflavones have received considerable attention as potentially preventing cancer and osteoporosis.

Glucosinolates are present in cruciferous vegetables such as cabbage, cauliflower, broccoli, mustard, etc., and are activators of liver detoxification enzymes. These phytochemicals are responsible for the pungent aroma and bitter flavour of cruciferous vegetables. Consumption of cruciferous vegetables provides protection against cancer and other forms of toxicity of reactive forms of oxygen.

The sprouts of certain crucifers, including broccoli and cauliflower, contain higher amounts of glucoraphanin (the glucosinolate of sulforaphane) than do the corresponding mature plants. Crucifer sprouts may protect against the risk of cancer more effectively than the same quantity of mature vegetables of the same variety.

Limonoids

Limonoids are terpenes present in citrus fruit. Limonoids are unique highly oxygenated tri-terpenoid compounds. Citrus limonoids appear in large amounts in citrus juice and citrus tissues as water-soluble limonoid glucosides or in seeds as water-insoluble limonoid aglycones. Citrus limonoids may provide substantial anticancer actions. D-limonene is the commonest monocyclic mono-terpene, found in orange peel oil and inhibits pancreatic cancer.

Polyphenols

Polyphenols are naturally occurring compounds found largely in fruits, vegetables, cereals and beverages. Legumes and chocolate also contain polyphenols. These molecules are secondary metabolites of plants and are generally involved in defence against ultraviolet radiation or aggression by pathogens. A diet rich in antioxidants is associated with a lower incidence of degenerative diseases. The major sources of dietary polyphenols are cereals, legumes (barley, corn, nuts, oats, rice, sorghum, wheat, beans, and pulses), oilseeds (rapeseed, canola, flaxseed and olive seeds), fruits, vegetables and beverages (fruit juices, tea, coffee, cocoa, beer and wine). Fruits such as apple, grapes, pear, cherry and various berries



contain up to 200-300 mg polyphenols per 100 g fresh weight. Similarly, a glass of red wine or a cup of coffee or tea contains about 100 mg polyphenols.

Although the knowledge of absorption, bioavailability and metabolism of polyphenols is not entirely known, it appears that some polyphenols are bioactive and are absorbed in their native or modified form by the microflora (bacteria) of the intestine. The active components of dietary phytochemicals (e.g. curcumin, resveratrol, capsaicin, catechins, vitamins, and beta-carotene) are believed to suppress the inflammatory processes, and most often appear to be protective against cancer, neurodegenerative disorders and cardiovascular diseases among others. A wide variety of polyphenols have been reported to possess substantial protective action on skin against UV radiation.

Omega-3 fatty acids

There is extensive interest in increasing consumption of omega-3 fatty acids because they are associated with many health benefits. The main food sources of the long-chain omega-3 fatty acids are fish, especially fatty species such as salmon, rainbow trout, mackerel, herring and sardines. Some plants, mainly canola, soybean and flax oils provide the 18-carbon omega-3 fatty acid, alpha-linolenic acid.

The benefit of omega-3 fatty acids in the treatment of people suffering from osteoarthritis is well known. In people who have osteoarthritis, increased consumption of omega-3 fatty acids and adequate intake of monounsaturated fatty acids such as those found in olive oil (and reduced consumption of omega-6 fatty acids) can improve symptoms and even sometimes allow a reduction in the use of non-steroidal anti-inflammatory drugs (NSAIDs).

One strategy to increase the availability of long-chain omega-3 fatty acids is to develop oilseed crops such as canola and soybean that contain stearidonic acid (18:4n-3). This omega-3 fatty acid occurs naturally in only a few plants such as black currant seed oil and echium oil.

Phytoestrogens

Phytoestrogens are non-steroidal phytochemicals quite similar in structure and function to gonadal estrogen hormone. They offer an attractive alternate for hormone replacement therapy (HRT) with beneficial effects on cardiovascular system and may even alleviate menopausal symptoms. They are potential alternatives to the synthetic selective estrogen receptor modulators, which are currently applied in HRT. On the basis of chemical structure, phytoestrogens can be classified as flavonoids, isoflavonoids, coumestans, stilbenes and lignans. They occur in either plants or their seeds. Soybean is rich in isoflavones, whereas the soy sprout is a potent source of coumestrol, the major coumestan.

Flavonoids have similar structure to oestrogens and have the capacity to exert

both oestrogenic and anti-oestrogenic effects and provide possible protection against bone loss and heart diseases. The precursors of these substances are widespread in the plant kingdom, but mainly found in Leguminosae and are especially abundant in soybean and its products, legumes, berries, whole-grains, and cereals. They share structural features with oestrogen, in the sense that the presence of particular hydroxyl groups can be positioned in a stereo chemical alignment virtually identical to one of the oestrogen. Populations in China, Japan, Taiwan and Korea are estimated to consume high quantities of isoflavones and women of these countries complain fewer incidences of osteoporosis and related health problems, especially hot flushes, cardiovascular diseases, lower incidence of hormone-dependent breast and uterine cancers. The main dietary source of phytoestrogenic stilbenes is resveratrol from red wine and peanuts. Although there are two isomers of resveratrol, *cis* and *trans*, only the *trans* form has been reported to be oestrogenic. It is found only in the skin of red grapes; in green grapes and white wine very low levels of *trans*-resveratrol are found. The main dietary sources of coumestans are sprouted legumes such as soy, and alfalfa; however, low levels have been reported in brussels sprouts and spinach. The highest concentrations of coumestans are found in clover and soybean sprouts.

Resveratrol

Resveratrol is a natural phytoalexin, made by plants in stress conditions and pathogen attack. It produces various physiological effects. At low concentrations that normally occur in food, resveratrol has been shown to exert neuro-protective effects as well as beneficial effects on the cardiovascular system. These effects are mostly attributed to its anti-oxidant properties. Most noticeable biological activities are anti-thrombogenic, anti-inflammatory, cardio-protective, neuro-protective, anti-aging and cancer preventive and therapeutic activities.

Resveratrol is found in considerable concentrations in grapes, peanuts, etc. It is the '*trans*' form of resveratrol that has been shown to display a much broader spectrum of pharmacological activity than its '*cis*' isomer. Stilbenes, in particular *trans*-

resveratrol and its glucoside, are widely reported to be beneficial to health and possess anti-oxidative, anti-carcinogenic and anti-tumour properties. The richest natural sources of resveratrol are dark grape extracts (*Vitis vinifera*) and giant knotweed (*Polygonum cuspidatum*, a perennial shrub). It is also found in abundance in labrusca and muscadine grapes. It is also present in other plants such as Eucalyptus, spruce and lily and in foods such as mulberries, peanuts, blueberries, strawberries, hops, and their products.

Phytosterols

Phytosterols are defined as plant sterols and plant stanols. Phytosterols lower total



and LDL blood cholesterol by preventing cholesterol absorption from the intestine, so they have been known as blood cholesterol-lowering agents for over the last half century. Phytosterols are naturally found in fruits, vegetables, nuts and principally oils. Dietary phytosterol intakes normally range from 160-400 mg/day with variations depending on food culture and major food sources. Studies have shown that maximum cholesterol lowering benefits are achieved at doses of 2-3g per day. Therefore, it implies the need for enriched functional foods, which provide enough phytosterols intake thereby contributing to lowering LDL cholesterol levels. Dairy foods remain a food of choice for use as delivery vehicle for many functional ingredients including phytosterols and there are many dairy products available in the global markets which are enriched with phytosterols. At the current growth rate of cardiovascular disease (CVD) in India, it is expected that the Indian market demand for phytosterol-fortified products would

increase in the near future. There is no doubt that phytosterol as a functional food ingredient will be a new approach to reduce LDL cholesterol through Indian dairy foods and hold a great promise for long term health management.

Terpenoids

The terpenes, also known as isoprenoids, are the largest class of phyto-nutrients in green foods and grains. These compounds are found in higher plants, mosses, liverworts, algae and lichens, as well as in insects, microbes or marine organisms. Their importance to plants relates to their necessity to fix carbon through photosynthetic reactions using photosensitising pigments. Animals have evolved to utilise these compounds for hormonal and growth regulatory functions (vitamin A) and, as it is now being understood, the presence of these molecules in animal tissues also provides a measure of protection from certain diseases, especially those related to chronic damage and growth deregulation. Terpenes are also used as skin penetration enhancers.

Synbiotics (Probiotics and prebiotics)

The concept of using a prebiotic and probiotic in a synergetic relationship to increase the relative number of beneficial bacteria in the gut is a new and promising area of investigation. Synbiotic is the combination of a prebiotic and a probiotic in which the prebiotic is used to increase the intestinal survival of the probiotic. They are used as an aid in the treatment of inflammatory diseases affecting the intestinal tract, such as inflammatory bowel disease and other syndromes. In addition, synbiotics are frequently recommended after a course of antibiotics as a means of restoring the microbiota within the intestinal tract to its normal, healthy state, as well as an aid in resolving uncomplicated cases of diarrhoea. They modify the composition of the microbiota of the gastrointestinal tract, restore the microbial balance and therefore have the potential to provide health benefits. The majority of probiotic microorganisms belong to the genera *Lactobacillus* and *Bifidobacterium*.

Continued on page 22

Numbers we need to keep in our memory



Dr. Bhupati Chakrabarti
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There are numbers around us and they are innumerable. Whether we like it or not, we really cannot do without them. We use them for wide variety of purposes in our daily life in social, cultural and personal sphere. Moreover, we do need to remember numbers, at least quite a few of them, in every step of our life.

First let us look at the numbers we need to count. These are positive integers and first came in the realm of mathematics as human beings first felt the need for counting; be it the members of the family, animals in a household, or trees in the garden. The numbers used for counting are known as natural numbers, presumably because these evolved naturally. Whether zero should be considered as a natural number is indeed a difficult and possibly to a certain extent an unresolved question. There are schools of mathematicians who are in favour of including zero while some others do not want zero in the family of natural numbers. Strictly speaking, zero is neither a positive number nor a negative number. If there is absence of anything we normally do not say that the object is present in zero number. This in fact may lead to a tricky situation because anything and everything that are not found, say in my apartment, may be referred to exist in zero number. That way we do avoid zero in counting and possibly feel more comfortable with that section of mathematicians who do not allow zero in the domain of natural numbers.

Though counting is the oldest exercise with numbers, in reality this is actually not all. Particularly we need units with numbers that give them special significance. For example, the number 50 may look otherwise innocuous, but it turns out to be quite different when we add the unit 'gram' with it to purchase a

small pack of spice, or 'kilometres per hour' to express the speed of a train and things become more familiar. However, often in everyday life we do not bother much about units and things can be carried on. If one is really looking for 500 grams of sugar the word 500 works well. Interestingly the

at every step. The qualitative statements have their own place, but quantification by the use of numbers makes the world go.

There is a general notion among the public that numbers are not very easy to remember. However, in reality we do remember quite a few numbers, occasionally quite large ones that are somehow connected to us. For a person 1968 may be an important number because he was born in that year, or for someone 1989 may significant as he lost his father that year. Longer numbers like birthdays of near and dear ones which actually involve both numerals and letters, are easy to remember though the same information can actually be put in a wholly numerical form. For example, a man may remember his

marriage anniversary as 05/12/1997, which is essentially 5 December 1997 in our way of writing the dates. Incidentally, in USA people may refer to the same date as 12/05/1997, where the month comes before the date. So the representations are also important.

1947 is a special number for all Indians and 15/08/1947 is even more significant for all of us. Do you know that according to the Saka calendar our independence came in the year 1869? The date was 24th of Shrawana. However, we possibly remember 1869 as the birth year of Mahatma Gandhi according to the Christian calendar. So, for us the number 1869 is doubly significant. As per the Islamic calendar the date of India's independence was the 27th day of Ramzan of 1366 AH (Hijri year). The year in traditional Bengali calendar corresponding to 15 August 1947 is 1354.

A lot of people all over India still use regional calendars for social and cultural activities though in official



Christian calendar for 1947 was exactly similar to 2014 calendar

putting the percentage sign (%) after the number 50 gives it a completely different connotation whereas 50+ conveys a different message even if you do not mention that in the latter case there is essentially a unit that you are referring to. This may be age in years or a train journey in hours or simply the price of something in rupees. In any case, we need numbers for quantification and that comes



(August 1947)

[The dates and days of August is similar that we observed in 2014]

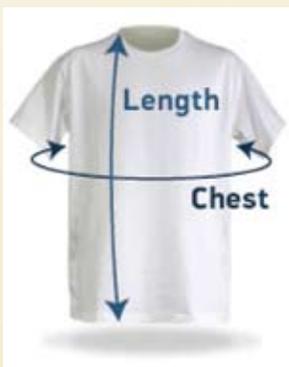
work the Christian calendar is in vogue. In West Bengal and in Bangladesh the birthday of Nobel Laureate poet Rabindranath Tagore is celebrated on the 25th of Vaishakha, the first month of the year in Bengali calendar, but this date falls between 7th and 9th, and occasionally on 10th of the month of May, in different years. People in general remember 25th Vaishakha as Tagore's birthday and are not actually bothered about the date in English calendar. Incidentally the death anniversary of Tagore is also marked as 22nd Shravana as per the Bengali calendar and that falls around 8th or 9th August.

With the entry of mobile phones in our life we often deal with 10 digit numbers but rarely remember them. Portability of the mobile phone numbers when one moves from one service provider to another has really helped us more to dodge the numbers. Here the numbers are known by names, as we store the phone numbers in the mobile handset against different names and just



Postage stamp of India highlighting August 15, 1947 (PI note at the price of the stamp; metric system was yet to be introduced)

find the name without bothering about the number. Incidentally, about a decade back before the mobile phones took off in a big way, telephones, now designated as landlines, had 6 to 8-digit numbers. Since we were not carrying any 'handset' at that time we could actually store quite a few of these telephone numbers not in the memory of our handsets but in our own memory. Of course we had the telephone directory apart from personal phone books to look up phone numbers; yet our memory used to play a very important role. It is true that we need not burden our memory with telephone numbers, but something new has come and demands the same accommodation in our memory.



How the sizes of the Tee shirts are linked with the letters



Credit Card with number and expiry date

Some special numbers that are actually a combination of the numerals and alphabets that people remember quite comfortably include vehicle numbers like those of one's own and of one's close ones, driving license number, one's passport and PAN card numbers, and postal PIN codes to mention a few. Now people need to keep in mind some personal identification numbers or PINs for the bank and ATM and credit card transaction. One needs to be really careful in remembering these numbers, particularly if one is using more than one credit card or debit card. Similarly, if you are using a few combination locks and you want to have different

number combinations as their keys, this is once again a challenging task as you need to remember not only the numbers but also the right combinations for different locks.

Today we need to remember quite a few passwords that we need to log in to a computer, e-mails, or for social network sites for banking or for using online payment of bills or similar things. These are actually often a combination of letters, numerals and special characters like punctuations, symbols, etc. Moreover, for security reasons we are advised not to use easily guessable numbers and words for passwords. We also are advised to memorise the passwords and not to put them in black and white because of security reasons. Yet a password may not be always very easy to remember, particularly when you are advised to avoid your 'easy to remember' words and numbers. So this

way 'numbers' that are actually different combinations of numerals and letters get into our memory and their quantity is increasing.

Remembering the sizes of one's garments is another area that deals with numbers. Interestingly, if you are purchasing for your own use, you not only know it but can really check it. This becomes actually necessary as some products indicate sizes by some letters like S, M, L, XL, etc., while some others come with numbers. Neither of these letters or the numbers indicating sizes is yet been standardised. So connecting these letters with numbers or vice versa needs some practice and experience. Moreover, when you



Letter box for India Post with PIN code

are going to purchase, say, a T shirt as a gift for a dear one you will have to guess a number keeping in mind his or her build. While this build is embedded in your memory the shopkeeper knows the number. For younger children they ask you the age and occasionally the build and convert them, often successfully to the size of the garment. For the younger ones the size changes quite fast and you need to accordingly shift the number if say only one year has passed by in between. So this is a special skill of these people and that also involves numbers.

Over the years with the advancement of human civilisation we have actually lost various skills while newer skills have been developed based on the needs. That has actually prompted us to become more conversant with handling of numbers. Particularly one will have to be alert about not only numbers but also of the units while describing the world around us. During the summer months while talking about the weather people often utter the numbers between 32 and 42 as this range of numbers express the temperatures of the days in Celsius scale. While driving along a highway you may feel a bit tense and apprehensive if the speedometer pointer crosses say 140, as we know our highways may not be safe for running a vehicle at a speed of 140 kilometres per hour. The human body temperature is considered to be normal if it is about 98.4 degrees Fahrenheit, yes Fahrenheit. And anyone having a temperature of say 102° F

we know needs medical attention. In the Celsius scale the normal body temperature is 37°C and a temperature of 38.8°C indicates fever, but people rarely use this scale for measuring body temperature. In contrast, the AC machines in rooms show the temperature in degrees Celsius. And we know what number in degrees Celsius would make us comfortable. These two temperature scales are different, but we are familiar with some numbers in both of these scales depending on the situation.



Thermometer showing temperatures both in $^{\circ}\text{C}$ and in $^{\circ}\text{F}$ (www.amazon.in)

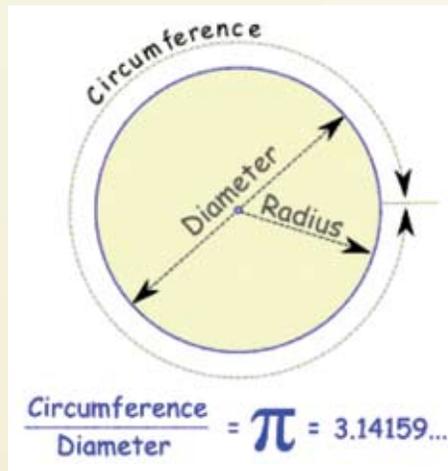
Some numbers are unique because they are so to speak numbers from nature. One very common example is the speed of light in a vacuum, or for that matter, in any specific medium. This is a constant and does not change with the frame of reference of the observer. No speed can exceed the speed of light in a vacuum. If we express it as 299,792,458 metres per second, it is indeed the correct value. But for common use 3 lakh kilometres per second is accepted although it differs from the actual value by about 0.069%. Before the introduction of the metric system, the speed of light was taken as 186,000 miles per second. Thus change of unit may give us different numbers representing of the same thing.

There are numbers that may be considered even more 'natural'. While going once round the Sun the Earth takes the time which is 365.25 times its single spinning period about its own axis. One complete spin is known as a day, or better yet to say an earth-day, and we mention that it takes 365.25 days for the Earth to complete one revolution around the Sun. This earth day is unique and comes from the natural motion of our planet. The length of the day has been subsequently subdivided into hours, minutes, and seconds by humans.

Another interesting and unique number is the ratio of the circumference and the diameter of a circle because it is always a constant irrespective of the size of the circle. This ratio, denoted by the Greek symbol π (pi), cannot actually be expressed as a rational number as it is a transcendental number that is non-terminating. Students

while studying science are required to remember more numbers, such as the atomic number of certain elements, density of certain elements and materials, molecular weights of some compounds and so on. The universal gravitational constant as the very name suggests is a universal constant. The charge of an electron, the temperature known as absolute zero (-273.16°C), Planck's constant, and a few others are represented by numbers in SI units used for scientific work. Similarly, students in other disciplines are asked to remember certain dates, years, or other numbers depending on the nature of the subject.

The ability to remember numbers often depends on our surroundings, work place, or some other social aspects. People living in a large city apartment usually remember the



π is the ratio of the circumference and the diameter of a circle and is a transcendental number

flat numbers of quite a few residents. We need to remember the television channels by numbers which vary for the package provided by diverse service providers. However, people remember the channel numbers they watch more frequently and tend to forget the others. It has been also observed that people do remember certain numbers because of their religious practices. These numbers are considered to be auspicious in the respective religion or have some special

significance. Similarly the dates of certain religious functions or cultural happenings are remembered by a section of the people much better than other dates.

People in some typical professions tend to better remember numbers that include the dates for the payment of bills, bank account related information involving numbers, and travel related numbers like the time of departure or arrival of trains, buses or flights. On the other hand the younger people are expected to remember their examination roll numbers, reference numbers to some applications they may have submitted and of course their marks in different examinations. A school-going child brings his or her report card that contains mostly some numbers and some letters indicating his performance. These are quite significant to both the guardians and the wards and these numbers, we like it or not, do play a role in different spheres of life.

The capability of storing numbers in memory depends on the age and social and academic background of individuals. Possibly the handsets of mobile phones are helping us storing some numbers related to our work and personal information, but such storage is not always advisable for security reasons. We actually want to deal with numbers depending on our necessity. Because of social changes and the use of information superhighway and digital gateways we are in a way compelled to remember more numbers for our everyday work. And this is not an easy task. The elderly people are in general not comfortable with numbers compared to their younger counterparts.

Is it possible to develop some sort of unique numbers for each person that can be used in all activities? There is security concern for such a venture that needs to be addressed. But if done, that will considerably reduce the burden of remembering numbers and will help everyone in continuing their work comfortably without the need to store dozens of numbers in memory and the fear of forgetting them.

Dr Bhupati Chakrabarti was an Associate Professor and Head in the Department of Physics, City College, Kolkata. He is at present the General Secretary of Indian Association of Physics Teachers (IAPT) and is actively involved in the Physics Olympiad related activities in the country. ■

Glaucoma

Risk Factors, Diagnosis and Self-help



Dr. Yatish Agarwal

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The underlying causes of glaucoma aren't completely understood. Evidence suggests that open-angle glaucoma tends to be inherited and a defect in one or more genes may be the cause behind its occurrence. People with a family history of glaucoma are more likely to develop it themselves.

Nevertheless, the exact genetic defects responsible for its occurrence haven't been identified. Other factors appear to contribute to the disease, but again, what these factors are and the relationships among them aren't known for certain. Although glaucoma is normally associated with increased eye pressure, people with normal or low eye pressure also can experience vision loss. Equally, some people with higher-than-normal eye pressure may never experience optic nerve damage.

Doctors have debated for many years about how damage to the optic nerve occurs. One theory holds that the pressure of backed up aqueous humour causes structural damage and ultimately death to the nerve fibres. Another theory suggests that nerve fibres die when small blood vessels that feed the optic nerve become blocked or when the blood supply is disrupted.

The cause of decreased drainage through the trabecular meshwork also presents a puzzle. The changes that slow drainage may be a result of normal aging, yet not all older adults develop glaucoma.



Risk factors

Since most people with glaucoma have no early symptoms or pain from increased eye (intraocular) pressure, it is important to know what puts you at increased risk of developing glaucoma. If you harbour one or more risk factors, it is best to see your eye doctor regularly so that glaucoma can be diagnosed and treated before long-term visual loss occurs.

Since chronic forms of glaucoma can destroy vision before any symptoms are apparent, it is important to be aware of these factors:

Age

Open-angle glaucoma is rare before age 40. The risk of developing glaucoma nearly doubles every 10 years after age 50. Primary open-angle glaucoma is most common in older adult women.

Family history of glaucoma

If one of your parents has glaucoma, you have about a 20 per cent chance of developing the disease. If you have a sibling with the disease, your chance of getting it is about 50 per cent.

Nearsightedness

Nearsightedness, also called myopia, is a name for impaired vision

in which a person sees near objects clearly while distant objects appear blurred. Severe nearsightedness increases the risk of developing glaucoma. An extensive study of eye health has found that nearsighted people had a two to three times higher risk of developing glaucoma than did people who were not nearsighted.

Structural abnormalities in the eye

Structural abnormalities of the eye can lead to secondary glaucoma. For example, pigmentary glaucoma is a form of secondary glaucoma caused by pigment granules being released from the back of the iris. These granules can block the trabecular meshwork.

Other risk factors include retinal detachment, eye tumours and eye inflammations such as chronic inflammation of the uvea and iris. Previous eye surgery may trigger secondary glaucoma.

Physical injuries

Severe trauma, such as being hit in the eye, can result in increased eye pressure. Injury can also dislocate the lens, blocking the drainage angle.

Prolonged corticosteroid use

Using corticosteroids for prolonged periods of time puts you at risk of getting secondary glaucoma.

Medical conditions

If you have diabetes, your risk of developing glaucoma is about three times greater than that of people who don't have diabetes. A history of high blood pressure or heart disease also can increase your risk.

Screening and diagnosis

Regular eye exams are the key to detecting glaucoma early enough for successful treatment. It is best to have routine eye checkups every 2 to 4 years after age 40 and every 1 to 2 years after age 65.

If you're at increased risk, your doctor may recommend more frequent monitoring. If your doctor suspects that you have glaucoma, he or she may perform a series of tests on you to detect any signs of damage.

Tonometry

The intraocular pressure can be measured by a tonometry test, which is simple, painless, routine eye examination that can be done in a doctor's office. Often the initial screening test for glaucoma, the test uses an instrument called a tonometer, of which there are many varieties.



The oldest tonometers measure pressure by means of a small metallic or plastic prism that is pressed lightly against the surface of the eye. The doctor asks you to lie in a relaxed state on an examination couch and instills local anesthetic drops to numb your eyes before measuring the eye pressure.

Two other techniques commonly in use today include air-puff tonometry and applanation tonometry. Air-puff tonometry blows a puff of air into the eye to measure the amount of force needed to indent the cornea.

An applanation tonometer is a sophisticated device that's usually fitted to a slit lamp. For this extremely accurate test, your doctor numbs your eyes with drops and has you sit at the slit lamp, where a small flat-tipped cone pushes lightly against your eyeball. The force required to flatten (applanate) a small area of your cornea translates into a measure of your intraocular pressure.



Ophthalmoscopy

Your eye doctor may use an instrument called an ophthalmoscope, which enables him or her to look directly through the pupil to the back of your eye. This permits examination of the inside of the eye to detect damage to the optic nerve (disc).

Mapping the optic nerve

Your eye doctor may also use laser light and computers to create a three-dimensional image of your optic nerve. This can reveal slight changes that may indicate the beginnings of glaucoma.

Visual field test

To check how your visual field has been affected by glaucoma, the doctor uses a perimetry test. One method, known as tangent screen perimetry, requires you to look at a screen with a target in the center. Your eye doctor manipulates a small object on a wand at different locations in your visual field. You indicate whenever you see the object come into view. By repeating this process over and over again, the doctor can map your entire visual field. This test can help detect vision loss due to glaucoma.

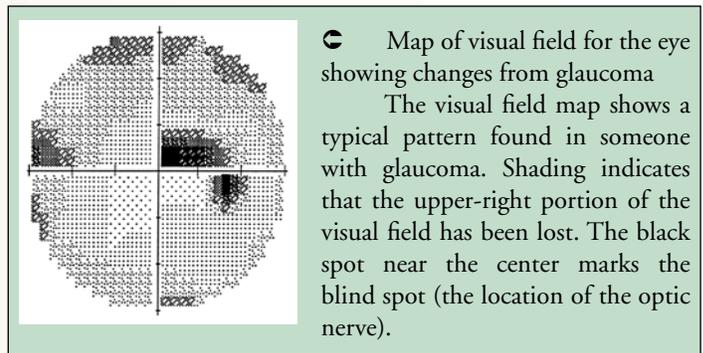
Gonioscopy

Your eye doctor may use a technique called gonioscopy to distinguish between open-angle glaucoma and angle-closure glaucoma. In this test, a special lens is placed on the eye to inspect the drainage angle.

Clinching the diagnosis

The diagnosis of glaucoma rests on several factors. These include an elevated intraocular pressure (pressure exerted by the fluids inside the eyeball), areas of vision loss and damage to the optic nerve.

In glaucoma, the optic disc will show visible signs of damage. The optic disc is the area where all the nerve fibres come together at the back of the eye before exiting the eyeball. An optic disc that



Map of visual field for the eye showing changes from glaucoma

The visual field map shows a typical pattern found in someone with glaucoma. Shading indicates that the upper-right portion of the visual field has been lost. The black spot near the center marks the blind spot (the location of the optic nerve).

has been affected by glaucoma appears indented, or excavated, as if someone scooped out part of the centre of the disk. This condition is known as “cupping”. The normal contour and colour of the disc may be affected by the loss of nerve fibres.

If your doctor determines that you have elevated intraocular pressure, an excavated optic disc and loss of visual field, you'll likely be treated for glaucoma.

If you have only slightly elevated eye pressure, an undamaged optic nerve and no visual field loss, you may not need treatment but more frequent examinations may be advised to detect any future changes.

If you have signs of optic nerve damage and visual field loss, even if your eye pressure is in the normal range, you may be treated to lower eye pressure further, which may help slow the progression of glaucoma.

Self-care

The best way to prevent damage from glaucoma is to know your risk factors and have regular eye examination. If you have glaucoma, the most important thing you can do is take your medications exactly as



prescribed. Frequent eye examinations will help your doctor monitor your eye pressure and keep you and your doctor aware of any changes in your vision.

The following self-care tips in tandem with medications help preserve vision and eye health:

Do not drink fluids in large amounts

Some people drink a litre or more of water soon as they rise up in the morning to cleanse the bowel. Practising this yogic habit may not be a good idea if you have glaucoma. The reason is simple: drinking a large amount of any liquid within a short time is likely to increase your eye pressure. Instead, you may opt to drink fluids in small amounts over the course of a day.

Give up on shirshasana

Some people are fond of practicing the yogic asana *shirshasana*. In this posture, also called the “supported headstand”, the body is completely inverted and held upright supported by the forearms, while the crown of the head rests lightly on the floor.

Since the practice of *shirshasana* may increase the flow of blood to the head region, and is liable to elevate the intraocular pressure, it is best not practised once you have been diagnosed with glaucoma.

Steer clear of herbal remedies

A number of herbal supplements are advertised as glaucoma remedies. They are not effective in preventing or treating glaucoma. Be cautious about herbal supplements, and discuss them with your doctor before trying them.

Maintain a healthy diet

Vitamins and minerals that are important for the eyes include vitamin A, vitamin C, vitamin E, zinc and copper.

Get regular exercise

Studies show that people with open angle glaucoma who exercise regularly — at least three times a week — can reduce their eye pressure by an average of 20 per cent.

However, angle-closure glaucoma isn’t affected by exercise, and people with pigmentary glaucoma, a form of secondary glaucoma, may experience increased eye pressure after exercise.

Talk to your doctor about an appropriate exercise programme.

Find healthy ways to cope with stress

Stress can trigger an attack of acute angle-closure glaucoma. Relaxation techniques, such as meditation and progressive muscle relaxation, may be helpful in dealing with stress.

(Next Month: *Medications and Surgery to rein in Glaucoma*)

Continued from page 28 **(Phytopharmaceuticals and their health benefits)**

Probiotic bacteria are used for the manufacture of a natural remedy, for controlling weight gain, increasing satiety, prolonging satiation, reducing food intake, reducing fat deposition, improving energy metabolism, treating and enhancing insulin sensitivity and treating obesity.

Thus phytonutrients have several health benefits and may be taken regularly to reduce the risk factors like high cholesterol, high blood pressure and diabetes. The future of nutraceuticals of both plant and animal origin holds exciting opportunities for the food industry to create novel food products containing bioactive food components. The government will need to persuade investors of the food industry for monetary rewards to be gained by investing in the value of nutraceuticals and functional foods. Moreover the need of the hour is to market the products so as to capture the interest and tastes of the consumers.

Dr. Charu Gupta is a gold medallist and is specialised in microbiology. He has filed around 25 patents related to nutraceuticals, cosmeceuticals, functional foods, probiotics and utilisation of agro-horticultural wastes for production of value added products.

Prof. Dhan Prakash has 35 years of research experience in life sciences, has worked as guest scientist at several universities abroad, and has filed 35 patents.

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Recent developments in science and technology



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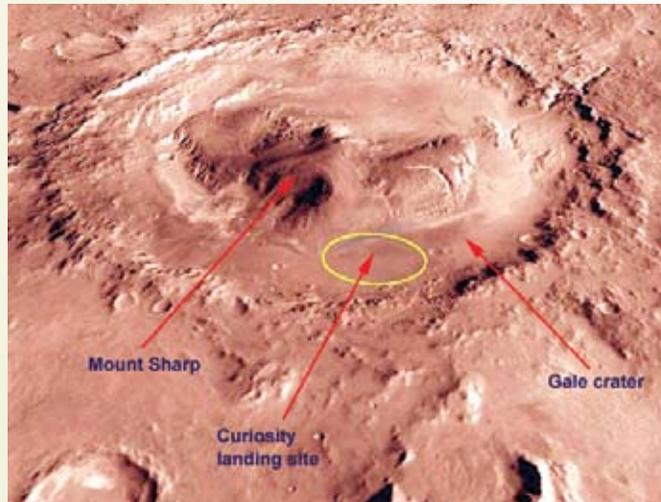
Evidence of lakes found on Mars

Mars has a unique mountain called Mount Sharp that sits at the centre of a large crater called Gale Crater. NASA's *Curiosity* rover landed on the floor of this crater in August 2012 to look for signs that Mars was once hospitable to life. This unique mountain has now provided evidence that Gale Crater was actually a large lake that was once filled with water and that Mars may have had many such lakes in the past.

Ever since it landed on the Red Planet more than two years ago, the *Curiosity* rover has been driving around the now-dry crater floor. In September 2014, the rover reached the foothills of the 5-kilometre-high Mount Sharp at the centre of the crater where it carried out drilling and analysis of rocks in the area. In December 2014, NASA announced that they have found evidence that Mount Sharp is a mountain of sediment, built over tens of millions of years by deposits of lake sediments through multiple cycles of water flowing into a large, shallow lake that could have lasted tens of millions of years. After the crater filled to a height of at least a few hundred metres, and the sediments hardened into rock, the accumulated layers of sediment were sculpted over time into a mountainous shape by wind erosion that carved away the material between the crater perimeter and what is now the edge of the mountain.

Mount Sharp is a curious formation: The layered mountain is made of different kinds of sediment. Some layers were probably deposited by a surrounding lake bed, and others seem more likely to be the result of river or wind deposits. NASA scientists believe that a large lake in the Gale Crater – or even a series of lakes that evaporated and then reformed – caused the

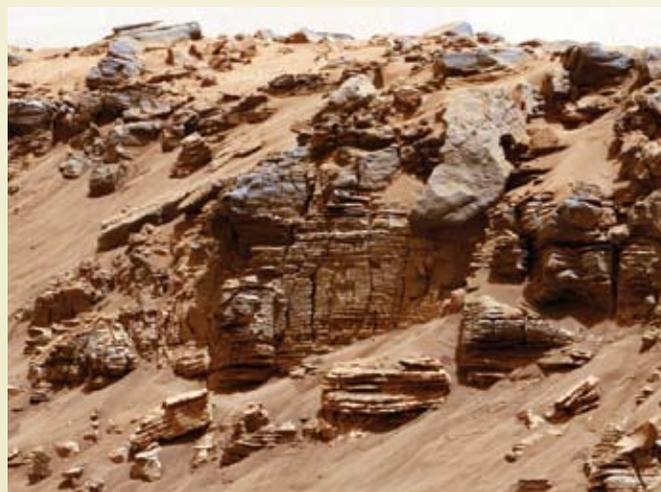
mountain's unusual formation. The rock layers in the lower flanks of Mount Sharp show alternate lake, river and wind deposits that bear witness to the repeated filling and evaporation of a Martian lake much larger and longer-lasting than any previously



Curiosity's approximate landing site within Gale Crater. Mount Sharp is the central peak. (Credit: NASA/JPL)

examined close-up.

According to NASA scientists, to have liquid water on the surface, Mars would have had a much warmer, heavier atmosphere than it does now, but at the moment, NASA scientists still are not sure how that



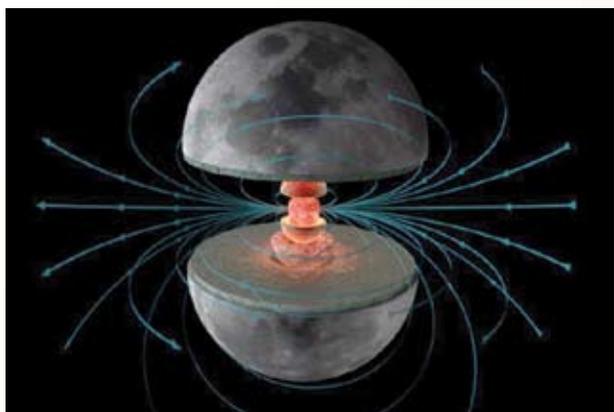
This evenly layered rock photographed by the Mast Camera on NASA's Curiosity Mars Rover shows a pattern typical of a lake-floor sedimentary deposit not far from where flowing water entered a lake.

atmosphere formed, or why it changed. Despite earlier evidence from several Mars missions that pointed to wet environments on ancient Mars, modelling of the ancient climate has yet to identify the conditions that could have produced long periods warm enough for stable water on the surface.

Curiosity currently is investigating the lowest sedimentary layers of Mount Sharp, a section of rock 150 metres high, dubbed the Murray formation. Rivers carried sand and silt to the lake, depositing the sediments at the mouth of the river to form deltas similar to those found at river mouths on Earth. This cycle occurred over and over again, ultimately leading to the formation of Sharp Mountain at the centre of the lake.

"If our hypothesis for Mount Sharp holds up, it challenges the notion that warm and wet conditions were transient, local, or only underground on Mars," says Ashwin Vasavada, *Curiosity* deputy project scientist at NASA's Jet Propulsion Laboratory in Pasadena, California. "A more radical explanation is that Mars' ancient, thicker atmosphere raised temperatures above freezing globally, but so far we don't know how the atmosphere did that."

According to *Curiosity* Project Scientist John Grotzinger, "As *Curiosity* climbs higher on Mount Sharp, we will have a series of experiments to show patterns in how the atmosphere and the water and the sediments interact. We may see how the chemistry changed in the lakes over time. This is a hypothesis supported by what we have observed so far, providing a framework for testing in the coming year." *Curiosity's* primary mission is to find signs that Mars was once hospitable to life.



New magnetic measurements of lunar rocks show that the ancient Moon generated a dynamo magnetic field in its liquid metallic core (innermost red shell). The magnetic field was recorded as magnetisation by rocks on the lunar surface. (Credit: Hernán Cañellas)

Moon's magnetic field explained

When Apollo astronauts brought back samples of moon rocks from their lunar landing missions in the 1960s and '70s, scientists were surprised to find that some of them were magnetic. At that time scientists had no idea that the Moon had ever had a magnetic field and were at a loss to explain why it apparently once had one. Recent studies show that billions of years ago, the Moon may indeed have had a magnetic field stronger than that of the Earth at present.

The Earth's magnetic field is generated by a 'dynamo process', caused by the fluid motion of a conducting material such as liquid iron in the planet's outer core and driven by the convection of heat. But the Moon is not large enough for convection to take place within it, and until now, scientists were unable to explain what else might generate the required liquid motion of iron inside the Moon.

Now, Ben Weiss, a professor of planetary sciences at the Massachusetts Institute of Technology and his student Sonia Tikoo have come out with a possible mechanism to explain Moon's magnetism. They suggest an exotic dynamo effect that may have powered an intense magnetic field in the past. They believe that the dynamo was stronger than the Earth's field today and persisted for a billion years from 4.2 billion years ago to 3.3 billion years ago.

This was a period of intense meteoroid bombardment in the solar system (*Science*, 5 December 2014 | doi: 10.1126/science.1246753).

However, according to planetary scientists, given the size of the Moon, convection that is thought to power all known planetary dynamos in the solar system today, is expected to produce surface magnetic fields on the Moon at least 10 times weaker than what was observed in the ancient lunar rocks.

To overcome this mismatch, Weiss and Tikoo suggest an exotic dynamo

mechanism in which the core was stirred by motion of the overlying solid mantle to explain ancient Moon's strong field intensity. According to them, this happened because the Moon's core and its mantle rotated around slightly different axes, and the boundary between them was not quite spherical, so their relative motion caused the fluid to mix around. The strength of this stirring was determined by the angle between the core and the mantle, and the distance between the Earth and the Moon, because the tidal gravitational tug from the Earth causes the Moon's mantle to rotate differently than the core. The motion of the mantle was more vigorous billions of years ago, when the Moon was closer to the Earth, hence the magnetic field was stronger.



The launch of the rocket TEXUS-49 carrying DNA on its outer surface from the Esrange Space Center in Kiruna, North Sweden. (Credit: Adrian Mettauer)

DNA can survive re-entry from space

DNA is the key genetic material found in all living organisms that decides all the characteristic of an organism. DNA is considered a delicate molecule, easily damaged or destroyed by heat or ionising radiation. But a recent study shows that it can survive temperatures of up to 1000°C encountered by space vehicles during re-entry into Earth's atmosphere. This surprising observation raises the possibility of extra-terrestrial life molecules arriving on Earth from space.

Sounding rockets represent an excellent platform for testing the influence of space conditions during the passage through Earth's atmosphere and re-entry on biological, physical and chemical experiments for astrobiological studies. The present study was conducted by a team of Swiss and German scientists who lined the exterior grooves of a rocket with fragments of plasmid DNA – a circular thread of DNA that would not function if it were damaged and lost its loop shape – to test the genetic material's stability in space. The plasmid DNA carried genes for fluorescence and antibiotic resistance. The rocket mission named 'TEXUS-49' was launched from an European base in Kiruna, northern Sweden and was originally intended to study the influence of gravity on the genes of human cells carried inside the rocket. At the end of the 13-minute round trip into space, it was found that some of those DNA molecules coated on the outer casing of the rocket remained intact during the hostile conditions of the flight and re-entry and could pass on genetic information after retrieval.

Subsequent analyses showed that DNA could be recovered from all application sites with a maximum of 53% in the grooves and that up to 35% of the DNA retained its full biological function. It was shown to confer antibiotic resistance to bacteria, and drive a fluorescent marker in nucleated cells thus proving its functionality. The researchers were intrigued to find that the DNA looked intact under a microscope (*PLoS ONE*, 26 November 2014 |

doi:10.1371/journal.pone.0112979).

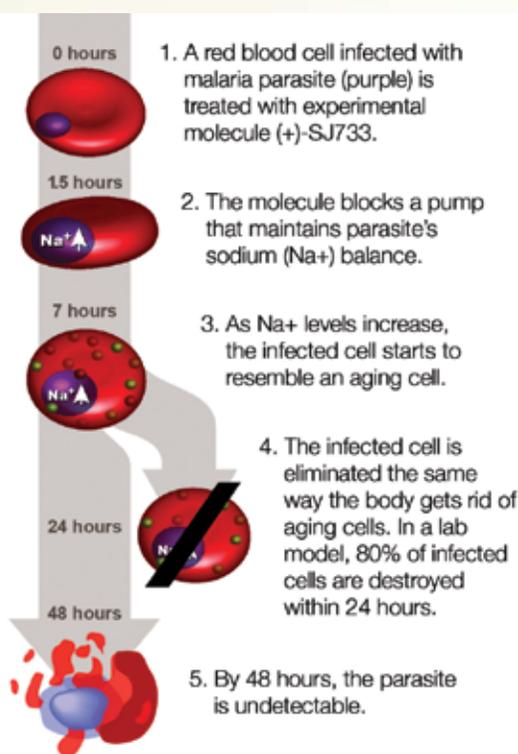
The experiment provides experimental evidence that the DNA's genetic information is essentially capable of surviving the extreme conditions of space and the re-entry into Earth's dense atmosphere. The new finding bolsters the belief of many scientists that comets may have brought organic building blocks of life such as amino acids to the Earth early in its history. The findings suggest that if DNA travelled through space on meteorites, it could have conceivably survived. Many scientists believe that DNA could certainly reach Earth from outer space in extraterrestrial material made of dust and meteorites, around 100 tonnes of which hits our planet every day.

This first evidence of plasmid DNA's survival also suggests that in future, DNA tests could be considered as a standard for measuring the effectiveness of decontamination procedures used in space programs. Returning spacecraft are routinely cleaned to protect Earth against the possibility of accidental contact with alien microbes.

New compound rapidly eliminates malaria parasite

Malaria is a disease that develops when a mosquito infected with a Plasmodium parasite bites a person. Once it gets into the bloodstream, the parasite invades and lives in the new host's red blood cells. According to the World Health Organization (WHO), malaria killed an estimated 6,27,000 people in 2012, the majority of them sub-Saharan African children under the age of 5. India has 12.8 crore suspected malaria cases.

Till now the only way to protect against malaria has been preventive – control of mosquito breeding and protection against mosquito bite using mosquito nets and mosquito-repellents. Once infected, the only treatments available were antimalarials such as chloroquine, quinidine, mefloquine, primaquine, etc., but mosquitoes have developed resistance against many of these drugs, making them ineffective. Recently, an international team led by researchers at St. Jude Children's Research Hospital, Memphis, USA has developed a new compound that can remove the malaria parasite from blood very fast and thus may slow development of resistance to antimalarial drugs. According



How (+)-SJ733 destroys deadly malaria parasite. (Credit: Joseph DeRisi, UCSF)

to the researchers, the new compound, (+)-SJ733, tricks the host immune system into destroying only infected red blood cells while leaving healthy ones alone. The new compound disrupts malaria parasite's internal sodium balance (*Proceedings of the National Academy of Sciences*, 5 December 2014 | doi: 10.1073/pnas.1414221111).

In the present study, researchers found

that (+)-SJ733 uses a novel mechanism to kill the parasite by recruiting the immune system to eliminate malaria-infected red blood cells. Whole genome sequencing of the *Plasmodium falciparum* revealed that (+)-SJ733 disrupted activity of the ATP4 protein in the parasites. The ATP4 protein functions as a pump that the parasites depend on to maintain the proper sodium balance by removing excess sodium. Researchers showed that by inhibiting ATP4 activity, a series of changes in malaria-infected red blood cells was triggered that marked them for destruction by the immune system. The infected cells changed shape and shrank in size. They also became more rigid and exhibited other alterations typical of aging red blood cells. The immune system responded using the same mechanism the body relies on to rid itself of aging red blood cells, but, significantly, it left uninfected red blood cells unharmed.

In a mouse model of malaria, a single dose of (+)-SJ733 killed 80 percent of malaria parasites within 24 hours. After 48 hours the parasite was undetectable. Laboratory evidence also suggests that the compound's speed and mode of action work together to slow down and suppress development of drug-resistant parasites, which has long undermined efforts to treat and block malaria transmission. Planning has begun to move (+)-SJ733 from the laboratory into the clinic beginning with a safety study of the drug in healthy adults.

Dream 2047

Articles invited

Vigyan Prasar invites original popular science articles for publication in its monthly science magazine *Dream 2047*. At present the magazine has 50,000 subscribers. The article may be limited to 3,000 words and can be written in English or Hindi. Regular columns on i) Health ii) Recent developments in science and technology are also welcome. Honorarium, as per Vigyan Prasar norm, is paid to the author(s) if the article is accepted for publication. For details please log-on to www.vigyanprasar.gov.in or e-mail to dream@vigyanprasar.gov.in

