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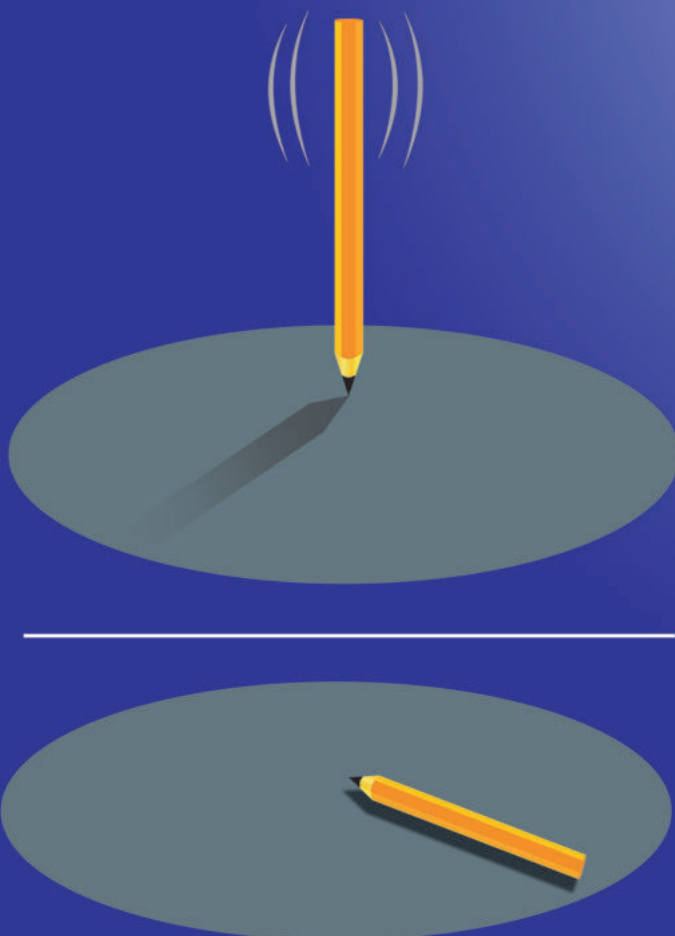
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Broken Symmetries



THE UNIVERSE
YOURS TO DISCOVER



INTERNATIONAL YEAR OF
ASTRONOMY
2009

Outreach Programmes
of Vigyan Prasar

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

Living with Cancer

Cancer occurs in most species of animals and in many kinds of plants, as well as in human beings; and is a leading cause of death in many countries. It accounted for 7.9 million deaths (13 per cent of all deaths) in 2007, out of nearly 60 million deaths worldwide. True, cancer strikes people of all ages, but it especially strikes the middle-aged and the elderly. Further, it occurs about equally among men and women, and can attack any part of the body. The parts that most often get affected are the skin, the digestive organs, the lungs and the female breasts. Further, most kinds of cancer are fatal without proper treatment.

More than 70 per cent of all cancer deaths occur in low and middle income countries. The five most common types of cancer that kill men (in order of frequency) worldwide are the cancer of lung, stomach, liver, colorectal (affecting the colon and the rectum) and oesophagus (gullet or the passage between the pharynx and the stomach). The five most common types of cancer that kill women (in the order of frequency) are the cancer of breast, lung, stomach, colorectal and cervical. Tobacco use is the single largest preventable cause of cancer in the world. Further, one fifth of all cancers worldwide are caused by a chronic infection. For example, human papilloma virus (HPV) causes cervical cancer and hepatitis B virus (HBV) causes liver cancer.

But, how does cancer start, anyway? Cancer is often triggered by carcinogens (cancer causing agents) such as tobacco smoke, and industrial chemicals such as arsenic, asbestos, and some oil and coal

products. Certain viruses also can trigger cancer. Inheritance of faulty genes (sections of DNA) could also play a part. Carcinogens damage specific genes known as oncogenes. Incidentally, oncogenes regulate vital processes such as cell division and growth, repair of damaged genes, and the ability of faulty cells to self-destruct. Indeed, most damaged genes are repaired as part of normal cell metabolism. But, some cells can get gradually altered, or mutated, by regular exposure to

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A VERY HAPPY AND PROSPEROUS 2009
THE INTERNATIONAL YEAR OF ASTRONOMY**

carcinogenic agents and thus fail to carry out their normal functions. Damage to oncogenes may force them to make altered versions of their chemicals within the cell. Thus, they work like molecular *locks* or *keys*, and *trick* the cell into functioning abnormally. Eventually, the cell may become cancerous and divide into two cells. These cells further divide in an uncontrolled manner retaining the cancerous changes. The total cell number doubles on each division. A solid tumour becomes detectable after twenty-five to thirty doublings, when it contains about a billion cells. The doubling time may range from one month to even two years depending on tumour type. All this from just *one* cell that undergoes cancerous changes and eventually culminates into a tumour!

Incidentally, cancer is a generic term used for a large group of diseases that can affect any part of the body. Malignant tumours and neoplasms are the other

terms employed for cancer. One defining feature of cancer is the rapid creation of abnormal cells that grow beyond their usual boundaries. These cells can then invade adjoining parts of the body and even travel to other organs, causing secondary growths or tumours. This process is referred to as metastasis. Metastases are the major cause of death from cancer. There are more than 100 identifiable forms of cancer that can be classified into three main categories. Carcinoma, which is the cancer of the epithelial tissue, affects the skin and the linings of the internal organs. Next, sarcoma is cancer of the connective tissue, such as cartilage, muscle and bone. Finally, 'fluid' cancer like leukaemia and lymphoma affects the blood stream and the lymphatic system. Sometimes, sarcoma is included in the third category since blood and lymph are forms of connective tissue. Leukaemia, sometimes called blood cancer, incidentally is a disease of the bone marrow, where blood cells are produced.

How is cancer treated? The three main methods of treating cancer include surgery, radiation therapy or radiotherapy, and drug therapy or chemotherapy. In several cases, treatment consists of combination of two, or even all the three methods, a procedure called combination therapy. Radiation from X-rays or radioactive substances kills cancerous cells as well as normal cells. Hence care must be taken to administer radiation doses that do not endanger life. Chemotherapy is

Contd. on page...27

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Jacobus Henricus van't Hoff

The First Nobel Laureate in Chemistry

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"The Academy has awarded the Nobel Prize for Chemistry to Jacobus Henricus van't Hoff, Professor in the University of Berlin, for his pioneering work on chemical dynamics and osmotic pressure in solutions. As a result of his investigations in the fields of atomic and molecular theory Van't Hoff has made the most important discoveries in theoretical chemistry since Dalton's time. With regard to atomic theory van't Hoff, following an idea put forward by Pasteur, advanced the hypothesis that elementary atoms have attachment points geometrically oriented in space – a hypothesis which in so far as carbon compounds are concerned led to the theory of the asymmetry of carbon atoms to the founding of stereochemistry. Still more revolutionary were van't Hoff's discoveries in the field of molecular theory..."

- C. T. Odhner, *President of the Royal Swedish Academy of Sciences in his Nobel Prize Presentation Speech in 1901*

Jacobus Henricus van't Hoff was the winner of the inaugural Nobel Prize in Chemistry in 1901. He was awarded the Prize "in recognition of the extraordinary services he has rendered by the discovery of the laws of chemical dynamics and osmotic pressure in solutions." His major contributions were in the areas of chemical kinetics, chemical equilibrium, osmotic pressure and crystallography. He introduced the modern concept of chemical affinity. His works have penetrated all branches of chemistry. He along with the Swedish chemist Svante Arrhenius (1859-1927), the American physicist Josiah Willard Gibbs (1839-1903) and the German chemist Wilhelm Ostwald (1853-1932) helped establish physical chemistry as a



Jacobus H. Van't Hoff

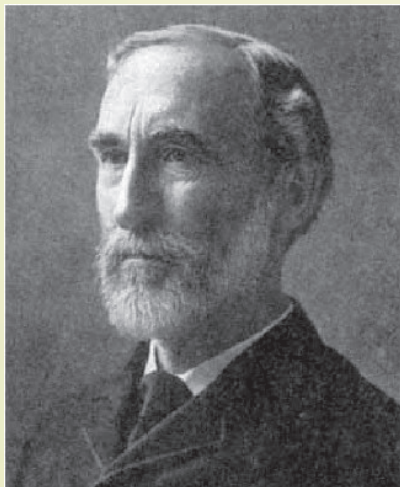
distinct discipline of chemistry - the branch of chemistry that deals with the interpretation of chemical phenomena and properties in terms of underlying physical processes, and with the development of techniques for their investigations. In 1887, van't Hoff, jointly with Ostwald founded the scientific journal *Zeitschrift für physikalische Chemie* (*Journal of Physical Chemistry*), which played an influential role in the development of physical chemistry. Van't Hoff and Joseph Achille Le Bell discovered the tetrahedral carbon.

Philosophy also interested van't Hoff. He particularly became interested in the philosophical ideas of the French philosopher Auguste Comte (1798-

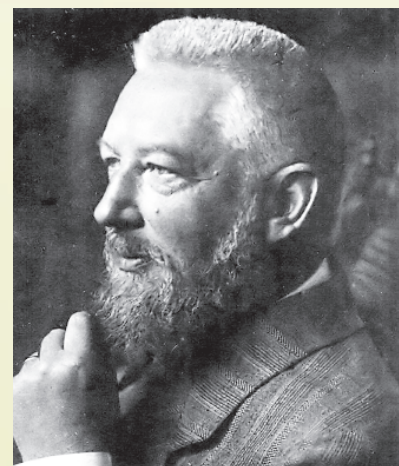
1857) and French literary critic and historian Hippolyte Adolphe Taine (1828-1893). He had developed a fascination for poetry. His idol in poetry was English poet Lord Byron (1788-1824).

Jacobus Henricus van't Hoff was born on 30 August 1852 in Rotterdam, The Netherlands (or Holland). His father, also named Jacobus Henricus van't Hoff, was a medical doctor. His mother was Alida Jacoba Kolff. In his early age he developed an interest in science and a love of nature. In his childhood he often took part in botanical expeditions. He had his early education in a private school

At the age of 17, van't Hoff decided to become a chemist. Despite of his parents' unfavourable reaction to his



Josiah Willard Gibbs



Wilhelm Ostwald



Auguste Comte

decision he entered the Polytechnic School at Delft in 1869 from where he obtained a diploma in chemical technology in 1871. He received his diploma in two years rather than the usual three years. However, during vacation-work at a sugar factory he decided to abandon the career of a technologist in favour of a purely scientific career. He spent a year studying mathematics at Leiden before he went to Bonn to study chemistry under August Kekulé (1829-1896). From Bonn he went to Paris, where he studied under the French chemist Charles Adolphe Wurtz (1817-1884). He returned to The Netherlands in 1874 and in the same year he received his doctoral degree of the University of Utrecht. His research supervisor was Eduard Mulder. His doctoral dissertation was entitled *Bijdrage tot de Kennis van Cyaanozijnzuren en Malonzuur* (*Contribution to the knowledge of cyanoactic acid and malonic acid*).

At the age of 23, van't Hoff unsuccessfully tried for a job of a schoolteacher. It is said that he was not given a job of a schoolteacher because he appeared to be a daydreamer. He then became a lecturer in chemistry and physics at the Veterinary College in Utrecht, which he joined in 1876. After spending two years in Utrecht, he moved to the University of Amsterdam as Professor of Chemistry, Mineralogy, and Geology. He remained there for almost

18 years. In 1896, van't Hoff moved to Germany to become an Honorary Professor at Berlin University by virtue of his membership of the Prussian Academy of Sciences.

Several months before submitting his PhD dissertation, van't Hoff published a research paper, which effectively created a new branch of chemistry called stereochemistry, the study of the spatial arrangement of atoms in molecules and the chemical and physical consequences of such arrangements. The term "stereochemistry" was coined by Victor Meyer. The paper was titled *Voorstel tot Uitbreiding der Tegenwoordige in de Scheikunde gebruikte Structuurformules in de Ruimte etc.* (*Proposal for the*



Lord Byron

development of 3-dimensional chemical structural formulae). It was published in the form of a pamphlet consisting of 12 pages of text and a 1-page diagram. His revolutionary ideas were further elaborated in his *Chimie dans l'Espace* (*The Chemistry in Space*), which was published in 1875. A German translation of this important work appeared two years later with an introduction by the German chemist Johannes Wislicenus (1835-1902). The English translation appeared much later in 1891.

Van't Hoff tried to solve the problems that originated with the discovery of optical compounds by the French physicist Jean Baptiste Biot

(1774-1862). Optical compounds rotate the plane of polarised light. Louis Pasteur had been able to relate this property for salts of crystalline solids, to the dissymmetry of the crystals. He found that some crystals of tartaric acid would rotate polarized light to the right and some to the left. Pasteur explained this by showing actual asymmetry of the crystals. There were two types of crystals, which were mirror images to each other. Pasteur was of the opinion that molecules themselves were asymmetric but he had no proof to support his belief. That Pasteur was thinking in the right direction became apparent from the optical activity of solutions of non-crystalline substances. Van't Hoff took the clue from the observation of Kekulé that the four groups linked to a carbon atom could be equally distributed in the space around it. Van't Hoff proposed a tetrahedral carbon atom. He proposed that if the four groups or atoms attached to a carbon atom are all different from each other, they could be arranged about the carbon atom in two ways. Such alternative arrangements of a molecule would be non-superimposable mirror images, or in other words, they would be stereo-isomers. He further proposed that one form would rotate polarised light to the left and the other form to the right.

It may be noted that Joseph-Achille Le Bel (1847-1930), independently of van't Hoff proposed the



Joseph-Achille Le Bel



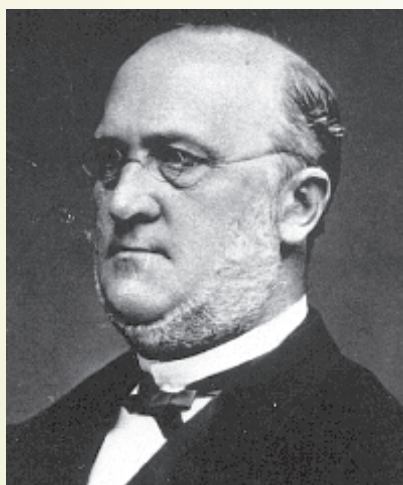
Adolphe Wurtz

idea of tetrahedral nature of carbon atom. However, he did not develop his ideas. It is strange that van't Hoff and Le Bell did not know of each other's work although they were working side by side in Wurtz's laboratory in Paris during the academic year preceding publication of their pioneering work. However strange it may seem but it appears that they developed the idea independently and did not even discuss it with each other!

Van't Hoff's ideas were considered very extraordinary and they were strongly criticised by the chemists. The German organic chemist Hermann Adolf Kolbe (1818-1884), the renowned editor of the German *Journal für praktische Chemie*, wrote: "A Dr. H. van't Hoff of the Veterinary School at Utrecht has no liking, apparently, for exact chemical investigation. He has considered it more comfortable to Pegasus (apparently borrowed from the Veterinary School) and to proclaim in his *La chimie dans l'espace* how the atoms appear to him to be arranged in space, when he is on the chemical Mt. Parnassus which he has reached by bold fly." Ironically Kolbe's criticism actually helped further van't Hoff's ideas because it brought the work of the young investigator to the attention of his older colleagues. Works done by other chemists supported the van't Hoff theory, or more appropriately the van't Hoff-Le Bell theory. In 1887, Johannes

Wislicenus published his work on geometric isomerism. It was a kind of stereoisomerism, which was not related to optical activity. The German chemist Victor Meyer (1852-1919) working in Heidelberg demonstrated the chemical effect of large-filling groups on organic molecules. Meyer termed this phenomenon "steric hindrance", which gave rise to stereoisomerism. Arthur Hantzsch and Alfred Werner working in Zurich studied the stereochemistry of organic compounds containing nitrogen. In Berlin, Emil Fischer used the concept of stereochemistry to interpret his fundamental research on carbohydrates.

In 1884, van't Hoff published his work on chemical kinetics. It was titled

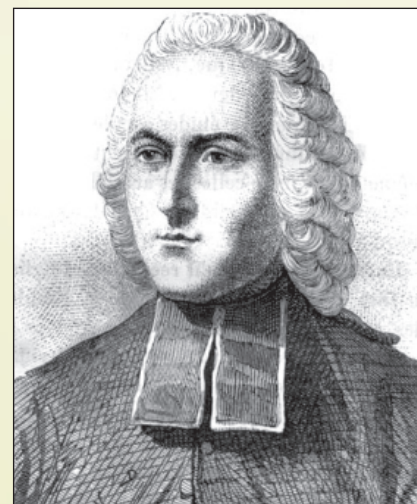


Hermann Adolf Kolbe

Etudes de Dynamique (Studies in Chemical Dynamics). In this work he introduced a new method for determining the order of a reaction using graphics and applied the laws of thermodynamics to chemical equilibria.

Van't Hoff made significant contribution in osmosis, the process by which solvent is transported through a semi-permeable membrane separating two solutions of different solute concentrations. The solvent is transported from the solution that is dilute in solute to the solution that is concentrated. Before describing van't Hoff's contribution to osmosis let us briefly describe the development of the concept of osmosis. It was the Abbe Jean-Antoine Nollet (1700-1770), who

first described osmotic behaviour in 1774. However, Nollet's work did not attract much attention. In 1826, the French physiologist Rene-Joachim-Henri Dutrochet (1776-1847) extended the scope of investigation of osmosis by applying it to plant movements. A simple osmometer constructed by Dutrochet showed that osmotic pressure could overcome gravity. Encouraged by this observation Dutrochet thought that osmosis might be responsible for many plant processes like rising of sap. In 1877, the German botanist and plant physiologist, Wilhelm Pfeffer (1845-1920) published his *Osmotic Investigations*. Though initially Pfeffer's work was not given due importance, it became the basis of further advancements in the understanding of osmosis and its significance. The Dutch plant physiologist and geneticist Hugo de Vries (1848-1935) showed that osmosis accounted for turgor; that is, the distension of a plant cell wall and membrane by the fluid contents. Turgor can be seen as the internal pressure of healthy plant cell, which results from the resistance of the semi-rigid cell wall to the osmotic pressure generated by the cell protoplasm. Turgor is essential for the cell growth and the transport of nutrients. De Vries' most important contribution to the understanding of osmosis was to bring Pfeffer's work on osmosis to the attention of van't Hoff, who approached the problem differently. By assuming that there is a similarity between solutions and



Abbe Jean-Antoine Nollet



Wilhelm Pfeffer

gases, he calculated osmotic pressures by applying the simple gas law equation, $p = CRT$ (where p stands for pressure, c for concentration, T for temperature and R is a constant). Here osmotic pressure is substituted for ordinary pressure of gases. The values of osmotic pressure calculated this way remarkably matched with the experimental values. This implied that osmotic pressure is determined by the concentration and temperature and that the structure of the membrane had no influence on it. The importance of van't Hoff's approach soon became apparent. It was found that van't Hoff's results could be used to determine the molecular weight of a substance in solution.

Besides being the first Nobel laureate in chemistry, Van't Hoff received a number of distinctions including the Davy Medal of the Royal Society of London (1893), and Helmholtz Medal of the Prussian Academy of Sciences (1911). He was appointed member of the Royal Netherlands Academy of Sciences. He was an honorary member of the British Chemical Society in London, the Royal Academy of Sciences in Gottingen, American Chemical Society and Academie des Sciences in Paris. A laboratory at the Utrecht University has been named after him.

Van't Hoff gave lot of importance to the power of imagination in scientific work. His inaugural address on taking up his professorship in Amsterdam was titled "The power of Imagination in

Science." According to him the most prominent scientists have possessed this quality in a high degree. His own discoveries were based on power of imagination.

Van't Hoff died on 1 March 1911 at Steglitz near Berlin, Germany.

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

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Nutraceuticals in Health and Disease Prevention

□ **Nataraja Thamizh Selvam**

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The term “nutraceutical” was coined from the words ‘nutrion’ and ‘pharmaceutical’ in 1989 by Stephen DeFelice, founder and chairman of the Foundation for Innovation in Medicine (FIM), Cranford, New Jersey, USA. According to DeFelice, a nutraceutical can be defined as “a food (or part of a food) that provides medical or health benefits, including the prevention and/or treatment of a disease”. These may include fortified foods as well as dietary supplements that can be sold in capsules, tablets or as powders. The idea behind the use of nutraceuticals is that certain organic extracts can have positive benefits on both the mind and body. From cancer to vertigo, claims of the effectiveness of nutraceuticals in combating or curing a long list of ailments are abundant.

Nutraceuticals may range from isolated nutrients, herbal products, dietary supplements and special diets to genetically engineered ‘designer’ foods and processed products such as cereals, soups and beverages. Doubtlessly, many of these products possess pertinent physiological functions and valuable biological activities. Dietary Supplement Health and Education Act of 1994 of the US Food and Drug Administration has extended the definition of nutraceuticals by including vitamins, minerals, herbs and other botanicals, amino acids and any dietary substance for use by humans to supplement the diet. This has led to a dramatic increase in the use of nutraceuticals. The goal of achieving an optimal or maximal state of nutrition

and health is becoming an increasing challenge with the introduction of many nutraceuticals.



Nutraceuticals are obtained from wide variety of herbs.

Categories of nutraceuticals

Nutraceuticals are non-specific biological therapies used to promote wellness, prevent malignant processes and control symptoms.



Fruits are a rich source of nutraceuticals.

These can be grouped into the following three broad categories.

1. **Nutrients:** Substances with established nutritional functions, such as vitamins, minerals, amino acids and fatty acids.
2. **Herbals:** herbs or botanical products as concentrates and extracts
3. **Dietary supplements:** Reagents derived from other sources and serving specific functions such as sports nutrition, weight-loss supplements and meal replacements.

Nutrients

The most commonly known nutrients are antioxidants and vitamins. Many potential benefits have been attributed to antioxidant use in the form of dietary intake or supplementation.

Herbals

Numerous nutraceuticals are present in medicinal herbs as key components. Several herbal extracts have been found to have beneficial effects in the treatment of a variety of ailments ranging from colds and flu to enlargement of the prostate. Vegetables, fruits, whole grains, herbs, nuts and seeds contain an abundance of phenolic compounds, terpenoids, sulphur compounds, pigments, and other natural antioxidants that have been associated with protection from and/or treatment of conditions such as cardiovascular disease and cancer. Foods and herbs with the highest anticancer activity include garlic, soybean, cabbage, ginger, licorice root and

the umbelliferous vegetables such as parsley, carrot, anise, caraway, celery, and dill.

Dietary supplements

Dietary supplements have also been developed to manage a variety of diseases. Researchers have found that minimally refined grains may reduce the incidence of diabetes and may be beneficial in the prevention of gastrointestinal cancers.

Regulatory system

The lack of quality control is a major area of concern for nutraceuticals. The quality of plant material and manufacturing processes used for nutraceuticals are regulated by food laws, which lack the specificity required for botanical drugs. Adulterants and numerous other types of impurity in nutraceuticals



Garlic has a high anti-cancer activity.

conceivably remain undetected simply because there is an almost total absence of specific quality control. Absence of quality control not only increases the risk to the consumer, it also results in a total lack of impetus to conduct adequate research that demonstrates the potential benefits of nutraceuticals or ensures their safety. The Indian Health and Dietary Supplement Association was created to represent pharmaceutical, nutraceutical, herbal, direct selling and other service-oriented industries and plans to affiliate with the International Alliance of Dietary Supplement Associations.

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Common Nutrients and Health Benefits	
Nutrients	Health benefits
Vitamins	
Vitamin A	Antioxidant, essential for growth and development, prevention and treatment of certain cancer
Vitamin D	Bones and teeth formation, absorption of calcium
Vitamin E	Antioxidant, boosting immune system
Vitamin K	Helps in blood clotting
Vitamin C	Antioxidant, formation of healthy bones, gums and teeth.
Vitamin B1	Helps in conversion of food into energy, neurological functions
Vitamin B2	Maintains healthy eye, skin and nerves functions
Vitamin B3	Helps in conversion of food into energy, neurological functions
Vitamin B6	Production of essential proteins
Vitamin B12	Helps to produce the genetic material of cells, formation of RBC, essential for various metabolic reactions
Folic acid	Necessary to produce the genetic materials of cells, essential in first three months of pregnancy for preventing birth defects.
Pantothenic acid	Aids in synthesis of cholesterol, steroids and fatty acids.
Minerals	
Calcium	Bone, teeth formation, nerve conduction
Iron	Energy production, oxygen transfer to tissues
Magnesium	Essential for healthy nerve and muscle function
Phosphorous	Strong bones and teeth, formation of genetic material
Trace elements	
Chromium	With insulin helps to convert carbohydrate and fats into energy
Cobalt	Essential component of vitamin B12
Copper	Hemoglobin and collagen production, absorption of iron from digestive tract
Iodine	Essential for proper functioning of thyroid
Selenium	Antioxidant, healthy functioning of heart muscles
Zinc	Cell reproduction, growth and development of children

Drunkenness:

Effects on Body, Withdrawal Signs and Treatment



□ Dr. Yatish Agarwal

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Drunkenness is nothing but voluntary madness. The simple truth is abuse of alcohol produces a host of acute and chronic damaging effects on a number of body systems. It makes a person tipsy in a short while because of its effects on the central nervous system, but its grievous effects in the long term hardly spare any organ system of the body. It can kill by causing severe hepatitis and liver damage, inflame the pancreas, inhibit the absorption of nutrients and damage the heart and blood vessels beyond repair. Read on, if you promise not to trip out!

Changes in brain and the nervous system

The mind-bending effects of alcohol begin soon after it hits the bloodstream. Within minutes alcohol enters the brain, numbing brain cells. By depressing both inhibitory and excitatory cells, alcohol can produce different effects in different settings and in different people. It can kick up a newfound vivacity in some, making them the life of the party, turn quite a few into morose uncommunicative souls, or rake up in still others a fighter's instinct leading to a brawl or worse. The effect largely depends on the amount of alcohol in the bloodstream. The initial reaction may be stimulation, but as drinking continues, sedating or calming effects occur. By depressing the control centres of the brain, it relaxes a person and reduces his or her inhibitions. Initially, it affects areas of thought, emotion and judgment. Small amounts of alcohol thus may relieve tension or fatigue, increase appetite, or produce an anaesthetic affect that numbs pain. The more a person drinks, the more the higher thought processes get out of control, bolstering self-confidence

"Drunkenness . . . is temporary suicide."

—Bertrand Russell

The Conquest of Happiness

and reducing inhibition, anxiety, and guilt. Then, as a person becomes intoxicated, painful or embarrassing situations appear less threatening and speech may become loud and slurred. Impaired judgment may lead to incautious behaviour, and physical reflexes and muscular coordination may become noticeably affected. Taken in large



not feel refreshed when he or she rises after a night's repose.

Excessive use of alcohol can produce several harmful effects on the brain and nervous system. A habitual drinker may develop Korsakoff's syndrome; there is thiamine deficiency, the person suffers a memory loss and loses the ability to learn new things, and may begin to replace fact with fantasy unconsciously in his or her memory. Up to 15 per cent of chronic drinkers develop peripheral neuropathy and suffer from limb numbness, tingling, and funny sensations. Some develop cerebellar degeneration and suffer from an unsteady stance and gait. While many of these changes are reversible, and a year or more of abstinence may allow much improvement, the damage becomes permanent if a person does not stop drinking. Some people may suffer irreparable loss of brain function, and develop a condition called alcoholic dementia.

Psychiatric disturbances

Alcohol is certainly a great mimicker. It can lead to a variety of psychiatric disturbances during heavy drinking or subsequent withdrawal. These include intense sadness lasting for days to weeks during a phase of heavy drinking; severe anxiety during alcohol withdrawal; psychoses during the severe form of the alcohol abstinence syndrome; and alcoholic paranoia marked by auditory hallucinations and paranoid delusions.

The gut machinery

Liver

Repeated exposure to large amounts of alcohol may cause serious liver damage. In

enough quantities, alcohol is a lethal poison - it can cause life-threatening coma by severely depressing the vital centres of the brain.

An evening on a binge of drinking can also end up in an alcoholic blackout. The person forgets all or part of what happened during drinking. This is a common problem, and affects 30 to 40 per cent people who take alcohol.

Alcohol also affects the sleep pattern. Even a few drinks can lull a person to sleep, but it also depresses the rapid eye movement (dream sleep) early in the night. The consequence is generally a fragmented sleep laden with bad dreams. The person does

the first stage of liver disease caused by alcohol, fat accumulates in the liver. This stage of the disease is known as 'fatty liver'. Most people do not notice symptoms of fatty liver, although in some people the liver becomes enlarged and tender. Some people with fatty liver develop hepatitis, which inflames and kills liver cells. Hepatitis is marked by jaundice, which gives a yellowish tint to the eyes and skin. Still later, people develop cirrhosis, an irreversible condition in which normal liver tissue is replaced by scar tissue. The scarring prevents blood from travelling freely through the liver, building up blood pressure in the veins that run from the intestine to the liver. Consequently, the liver can no longer process toxins efficiently, causing poisons to build up in the blood. The body begins to bloat, the kidneys may also fail and rapidly the condition can become fatal. Many cine stars, writers, poets, artists and commoners die a painful death because of this ill effect.

Pancreas

Chronic intake of alcohol or an alcoholic binge can cause a severe acute or chronic inflammation of the pancreas. The condition is called pancreatitis, and it can have serious and potentially fatal outcome.

Food pipe, stomach and bowel

Acute alcohol intake can severely damage the inner lining of the food pipe and the stomach, and lead to vomiting, bleeding and, sometimes, a tear in the wall. The bowel movement can increase leading to diarrhoea.

Increased cancer risk

Alcohol also increases the risk of cancer developing in the oral cavity, gullet, food pipe, stomach, liver and pancreas.

Heart and circulation

One to two drinks a day over long periods may have a beneficial effect on the heart and the circulation through an increase in the high-density lipoproteins and changes in the clotting mechanism. Yet, chronic heavy drinking can damage the heart muscle severely. A large number of cardiomyopathy (a disorder of the heart muscle) cases are

caused by alcohol abuse. In this heart disease, the heart muscles enlarge and become flabby, reducing the heart's blood-pumping ability. This causes a potentially fatal backup of fluid in the lungs. It also reduces the flow of blood through the kidneys, which normally filter excess salts and water out of the blood.

A binge can also lead to a holiday heart! The heartbeat can suddenly become irregular. If the rhythm becomes severely awry, the heart can pack up, leading to sudden death. The consumption of three or more drinks per day can also result in a dose-dependant increase in blood pressure. Heavy drinking is thus a reversible cause of hypertension. Heavy drinking is also associated with brain stroke. This often



happens within 24 hours of a binge.

Blood cells

Heavy and prolonged intake of alcohol can lead to anaemia, decrease the production of white blood cells, and increase the risk to infections and cancers. Some people also develop a tendency to haemorrhage because of a drop in platelet count.

Sexual functioning

Modest alcohol intake increases sexual drive in men but dampens the performance by decreasing erectile ability. Men who are habitual drinkers may show irreversible atrophy of the testes and loss of sperm cells.

In women, repeated ingestion of alcohol in high doses may lead to a decrease in ovarian size and function, stoppage of menstruation, and infertility and abortions.

Foetal development

Alcohol abuse in pregnant women can damage the foetus. Women who drink excessive amounts of alcohol while pregnant run a high risk of having a baby born with foetal alcohol syndrome. This syndrome features a combination of mental and physical defects, such as retardation, a small head, and poor muscle tone. Some babies exposed to alcohol during foetal maturation develop foetal alcohol effect, which produces more subtle symptoms, including behavioural problems, difficulty in paying attention, or the inability to think abstractly.

Nutritional derangement

Heavy and chronic intake of alcohol seriously disturbs the body chemistry. Alcohol is rich in calories and can provide substantial amounts of energy. Heavy drinkers lose their appetite and tend to obtain calories from alcohol rather than from foods. However, if it constitutes the primary source of calories in place of food, the body develops a deficiency of vitamins, minerals, and other essential nutrients.

Due to its numerous ill effects, chronic alcoholism leads to a loss of billions of rupees in lost productivity, illness, and premature death every year. Alcoholism is also one of the biggest causes of motor vehicle accidents.

The withdrawal syndrome

Sudden withdrawal of alcohol from a person who has developed physical dependence on it can lead to a number of symptoms. The picture can vary between individuals, and may include shaky or jittery hands, increase in heart rate, breathing rate and body temperature, sleeplessness often accompanied by bad dreams, irritability, and stomach upset. These symptoms begin within five to ten hours of the last dose, peak in severity on day two or three, and improve by day four or five. Anxiety, sleeplessness, and other mild symptoms may persist for six months or more, and may contribute to return to drinking.

About five per cent habitual drinkers show severe withdrawal symptoms. They suffer from confusion, and hear voices, see horrifying images or feel objects that do not exist. It takes several days before these symptoms disappear and the mental state becomes clearer. A small number may suffer from generalised convulsions, called 'rum fits', within 48 hours of stopping drinking. In some cases, they may experience 'delirium tremens', which produces confusion, severe agitation, terrifying hallucinations, and sleeplessness. As this delirium progresses, the hands develop a persistent and uncontrollable shaking that may extend to the head and body.

Treatment

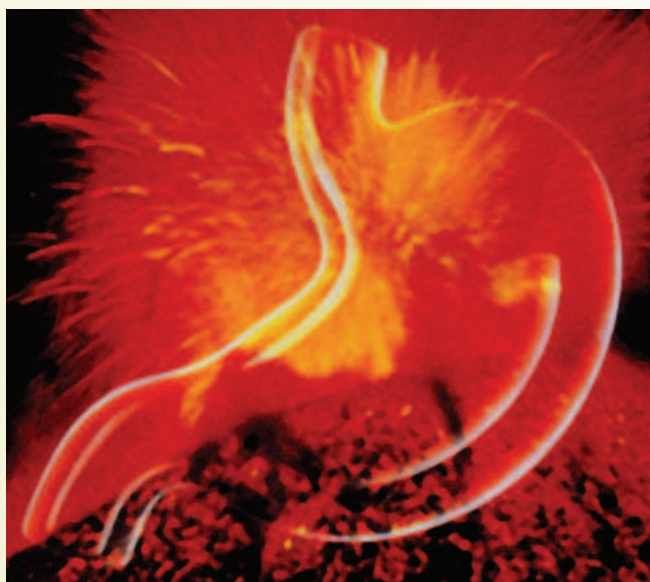
Most people who suffer from alcohol dependence or alcohol abuse are reluctant to take any treatment. In fact, most of them deny the problem. Since alcohol has serious health and social consequences, there is a definite need for them to be pressured to give up drinking. Some habitual drinkers seek treatment when they run into health or legal problems. If you are concerned about a friend or family member, go ahead and take a pro-active role and discuss the possibilities with a physician who specialises in de-addiction therapy.

There is a wide range of treatments available and they need to be tailored to the needs of the individual. The treatment must begin with a total evaluation, estimation of the severity of the dependence, counselling and management as an outpatient, or a residential inpatient stay.

The first step is to try and determine the extent of the problem. If a person has not lost control over the use of alcohol, the treatment may involve simply motivating the person to stop. This can be achieved with the help of counselling or a brief intervention. Effective treatment is impossible unless the person accepts that he or she is addicted and is unable to control drinking. The intervention usually involves alcohol-abuse specialists who can establish a specific

treatment plan. Interventions may include goal setting, behavioural modification techniques, use of self-help manuals, individual and group therapy, participation in self-help groups, educational lectures, family involvement, activity therapy, counselling, and follow-up care at a treatment centre.

If the person has lost control and has turned into an alcoholic, the above listed steps alone are generally not sufficient and the beginning of a successful abstinence programme requires active surveillance under a specialised residential treatment



facility or a separate unit within a general or psychiatric hospital. The treatment begins with detoxification. This usually takes up to a week, and the patient may need medications, such as diazepam to prevent delirium tremens and to treat other withdrawal symptoms. At the same time, steps are taken to provide the patient with adequate nutrition and rest. The patient often needs good amounts of multiple B vitamins. Each patient also requires a complete health check up. Chronic alcoholics are known to develop high blood pressure, increased blood sugar and liver and heart disease, and need active treatment.

Once the patient recovers from acute withdrawal symptoms, the process of rehabilitation must begin. Group and individual counselling, and psychological support can keep the motivation level high

and reinforce the resolve to abstain. The family and friends also need to know that they must stop protecting the patient from the problems caused by alcohol. Those who are weak-willed, but have a desire to stop may take help of medications. An alcohol-sensitising medication called disulfiram (Antabuse) may be useful. If a person drinks alcohol, the medication produces a severe physical reaction that includes flushing, nausea, vomiting and headaches. Disulfiram will not cure alcoholism nor can it remove the compulsion to drink. But it can be a strong deterrent. Naltrexone, a medication long known to block the narcotic high, can also reduce the urge to drink. It may, however, lead to serious side effects, including liver damage. These medications cannot be given to a person who is not willing to stop.

While the person makes a recovery, he or she must also return to useful and active life. This may require vocational rehabilitation, family support and sexual counselling. Positive life enforcement can go a long way in keeping the person from returning to the old ways. They need constructive engagements such that it is easier to deal with free time without alcohol, develop a non-drinking social circle, and handle stresses on the job and at home without alcohol. Whether the treatment begins in an inpatient or an outpatient setting, the patient needs to stay in touch with the treating physician for at least six months.

Self help groups, such as Alcoholics Anonymous (AA), established in the US in 1935 and now with branches all over the world, offer continuing support and help in abstinence from alcohol, managing any relapses and begin life anew. The organisation functions through local groups that have no constitutions, officers, or fees. Anyone who has a drinking problem may become a member.

A large number of alcoholics are able to win the battle. The path to success is self-determination.

Broken Symmetries

□ Biman Basu

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Ever since Galileo, physicists have been guided in their quest for the ultimate laws of nature by the search for symmetries, or properties of nature that appear the same under different circumstances. One common example of obvious symmetry found in nature is a snowflake, which looks the same when rotated by one-sixth of a turn. Another is Einstein's theory of relativity, according to which the laws of physics are the same no matter what the inertial frame of reference is. But experiments conducted during the latter half of the 20th century revealed several instances in particle physics where symmetries might be hidden, or 'broken' in actual practice.

A simple example of broken symmetry could be an apple. A whole apple is symmetric around its vertical axis, but once cut, this symmetry is broken. There are also perfectly symmetric situations in life where we must break the symmetry to proceed. Consider a round dinner table with napkins placed between the plates. If there are six plates and six napkins, how to decide whether one should take the one to the left or the one to the right? Both situations represent identical results. Someone has to start, however, by breaking the symmetry. Once this is done, everyone knows which side to choose. If one person picks up the napkin on the right then all others will have follow the same. This phenomenon occurs at the fundamental levels of physics, too. It took the mathematicians up to the 19th century to systematically study the mathematical structure behind symmetric patterns to understand it.

Nature's laws of symmetry have existed in our universe from the very beginning, although in course of time there have been some that have spontaneously lost their original symmetry. According to physicists, at the time of the Big Bang some 14 billion years ago, when our universe came into being, equal amounts of matter and antimatter were created. Had they

remained as such, they ought to have annihilated each other in no time, leaving behind only radiation. But we are all here and we know that the universe is made up of matter. So, somehow there must have been a slight excess of matter over antimatter soon after the Big Bang. This tiny deviation from perfect symmetry – one extra particle of matter for every ten billion particles of antimatter – seems to have been enough to make our universe form and survive. It is this broken symmetry that seems to have caused our cosmos to survive and evolve into the present state. This excess of matter provided the seed for the creation of our universe, which later filled with galaxies,



Snowflake

stars and planets. But what lay behind this symmetry violation in the cosmos that led to the slight excess of matter has long been a mystery for cosmic physicists.

It was around the middle of the 20th century that broken symmetry first appeared in studies of the basic principles of matter. At this time physics was thoroughly involved in achieving its greatest dream – to unite all nature's smallest building blocks and all forces in one unified theory. But it was easier said than done. To begin with, particle physics only became more and more complicated. New accelerators built after the Second World War produced a constant stream of particles that had never been seen before. Most of

them did not fit into the models physicists had at that time, that matter consisted of atoms with neutrons and protons in the nucleus and electrons round it. Deeper investigations into the innermost regions of matter revealed that protons and neutrons each were made up of a set of three quarks. The particles that had already been discovered by then also were shown to consist of quarks. However, today, almost all the pieces of the puzzle have fallen into place and a 'Standard Model' has been formulated to describe the elementary particles that make up matter.

The Standard Model, at least for the time being, includes three of nature's four fundamental forces along with their messengers, particles that convey the interaction between the elementary particles. The carrier of the electromagnetic force is the photon with zero mass; the weak force that accounts for radioactive disintegration and causes the Sun and the stars to shine is carried by the heavy W and Z boson particles; while the strong force is carried by gluon particles, which hold the atomic nuclei together. Gravity, the fourth force, which keeps us safe on the ground and makes the planets go round the Sun, has not yet been incorporated into the model and poses a colossal challenge for physicists today.

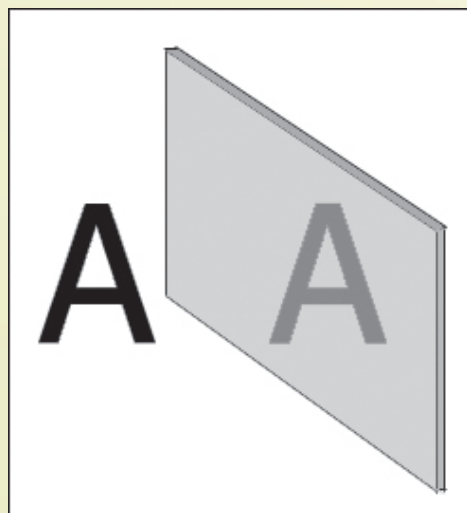
Coming back to the topic of symmetry, the basic theory for elementary particles describes three different principles of symmetry: mirror symmetry, charge symmetry and time symmetry (in the language of physics, mirror symmetry is called P, from parity; C stands for charge symmetry; and T for time symmetry). In mirror symmetry, all events should occur in exactly the same way whether they are seen directly or in a mirror. There should not be any difference between left and right and nobody should be able to decide whether they are in their own world or in a looking glass world, as is the case of reflection of letter A in a mirror. Charge symmetry states that particles should behave exactly like their counterparts called antiparticles, which have exactly the same properties but the opposite charge, as negatively-charged electron has the positively-charged positron as the antiparticle. And according to time

	Fermions			Bosons	
Quarks	u up	c charm	t top	γ photon	
	d down	s strange	b bottom	Z Z boson	
				W W boson	
Leptons	ν_e electron neutrino	ν_μ muon neutrino	ν_τ tau neutrino	g gluon	
	e electron	μ muon	τ tau		
				Higgs boson	

The Standard_model

symmetry, physical events at the micro level should be equally independent whether they occur forwards or backwards in time.

In the past it was widely believed that natural laws should be perfectly symmetrical and absolute and that they should be valid throughout the whole of the universe. This approach seems true for most situations, but not always. That is why broken symmetries became the subject of intense research in physics and have been already rewarded with several Nobels. The 2008 Nobel Prize in Physics has also gone to three physicists for their work relating to the origin of the broken symmetry and the so-called symmetry breaking mechanisms. The winners are: Yoichiro Nambu of the University of Chicago, USA, Makoto Kobayashi of High Energy



Mirror symmetry

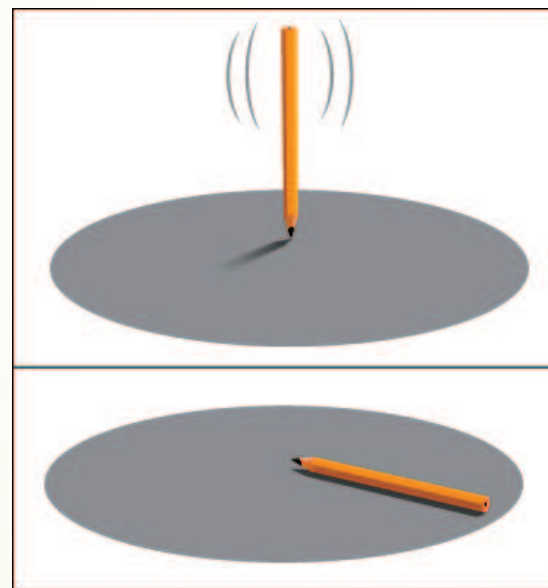
Accelerator Research Organization (KEK), Tsukuba, and Toshihide Maskawa of Yukawa Institute for Theoretical Physics (YITP), Kyoto University, Japan (see *DREAM 2047* December 2008).

As early as 1960, Yoichiro Nambu had described a mechanism called spontaneous broken symmetry in sub-atomic physics. Spontaneous symmetry breaking occurs whenever the forces within a system are in some way symmetric, but the lowest energy 'ground state' that the system settles into does not share that symmetry. The classic example is one of a pencil balanced on its tip. Although unstable, as long as it is standing it has a symmetrical existence in which all directions are equal. But this symmetry is lost when it

falls over – now only one direction counts. At the same time, its condition has become more stable; the pencil cannot fall any further, as it has reached its lowest level of energy. Thus in order to reach its ground state, the pencil has to spontaneously break the symmetry of the forces and tip one way, but *a priori* one has no way of predicting in which direction it will fall.

Nambu assumed a much more subtle symmetry between protons and neutrons involving the way the particles spin and the fact that, to the strong force, a proton is essentially indistinguishable from a neutron. He then showed that if the symmetry were spontaneously broken, particles that interact through the strong nuclear force such as the pions (pi mesons) had to emerge from the conceptual process with exactly the mass and other properties they were already known to have. That was a big victory for the time, and it laid the groundwork for many further advances, as spontaneous symmetry breaking of other sorts shows up throughout the Standard Model. In fact, physicists believe that the spontaneous breaking of a different symmetry explains how the sub-atomic particles obtain their mass and that the long-sought Higgs boson is a necessary by-product of it. Nambu's work was also able to explain how the four fundamental forces on Nature could be so different, and how elementary particles, including the particles that mediate those forces, can have such disparate masses – for example, the top quark is more than 300,000 times heavier than the electron, whereas the photon has no mass at all.

The spontaneous broken symmetries that Nambu studied differ from the broken symmetries described by Makoto



Broken symmetry

Kobayashi and Toshihide Maskawa. The latter two set out to explain the mysterious asymmetry between matter and antimatter known as 'charge-parity (CP) violation'. That subtle effect had been seen in 1964 in the decays of particles called K-mesons and their antimatter counterparts, which themselves were found to consist of smaller particles called quarks. At the time, physicists knew of three kinds of quarks: 'up' and 'down' quarks that joined in threes to form protons and neutrons, and the 'strange' quark that could bind with an anti-up or an anti-down anti-quark to form K-mesons. Kobayashi and Maskawa found that they could explain CP violation if there existed at least three other quarks. The presence of those extra quarks would create just enough mathematical options so that in meson decay, effects similar to the interference between waves can create small difference between how matter and antimatter behave. It did not take long for the predicted quarks to appear in ever-more powerful particle collisions in accelerators. The charm quark was discovered in 1974, the heavier bottom quark was detected in 1977, and the super-heavy top quark showed up in 1995, vindicating the predictions of Kobayashi and Maskawa.

According to experts, the work of the three Nobel laureates would help set the conceptual table for the world's new most powerful atom smasher, the Large Hadron Collider (LHC) at CERN. Although currently down for repairs, next spring the LHC will start to chase the Higgs boson and take an even closer look at matter-antimatter asymmetry.

Editorial (Contd. from page 39)

particularly effective against leukaemia or lymphoma, but is also used against other forms of cancer. These anticancer drugs also function like radiation – they too kill normal cells and have side effects ranging from nausea and hair loss to high blood pressure.

Indeed, a third of cancers could be cured if detected early and treated adequately. All patients in need of pain relief from cancer could be helped if current knowledge about pain control and palliative care were applied. 30 per cent of cancers could be prevented by not using tobacco, having a healthy diet, being physically active, and preventing infections that may cause cancer. Earlier, the methods of treatment gave little hope for recovery. But, of late, the methods of diagnosing and treating the disease have greatly improved. Today, about one-third of patients treated for cancer recover or live much longer than they would without the treatment. The research over the last few decades, however, has given us new insights, and has shown that it may not be possible to develop a simple cure for the disease. In other words, our dream of 'conquering this dreaded disease' after all may not be quite realisable. Rather, we shall have to learn to live with the enemy!

With the advent of genomics (the branch of genetics that studies organisms in terms of their full DNA sequences), biologists are starting to learn why cancer is such a wily foe. To begin with, it is necessary to realise that mutations that can turn cells cancerous and drive a tumour's growth take place in many diverse ways. It is this enormous diversity of mutations that gives these cancerous cells endless opportunities to outwit our defence mechanisms. Hence, by tracking these mutations, and targeting each of them with suitable drugs, we may be able to bring cancer under control. It may even be possible to harness the human immune system, which is capable of mounting its own targeted responses, to keep the tumours in check.

Of late, biologists have been collecting new information about the molecular pathways (mechanisms) that drive cancer. This has led them to question the traditional

method of classifying the tumours according to where they appear in the body. They are realising that what matters are the *particular* mutations which make the cells in a tumour grow in an uncontrollable fashion. Two patients with cancers in completely different tissues, but triggered by the same mutation, may have more in common with each other than patients with tumours in the same organ but caused by different molecular mechanisms. Conversely, two patients with superficially the same type of cancer may have very different prognoses, depending on the underlying mutations involved.

Once we throw away the notion that cancer is an anatomically defined disease and focus on the molecular abnormalities, the entire perception and approach for treating cancer changes. Conventional chemotherapy and radiotherapy work by being extremely toxic to dividing cells. While these treatments damage the fast growing tumour cells, they also have an adverse effect elsewhere in the body. The current trend is to get away from this model and understand the *changes* that occur in cancer that differentiate it from normal cells. We could then come up with drugs that specifically target those changes according to a recent report in the *New Scientist* (25 October 2008). It would then be possible to transform cancer from a lethal disease into a chronic condition that people may be able to live with almost indefinitely. Treatments may probably require cocktails of targeted drugs that will have to be adjusted as tumours mutate. We may note that this approach is similar to the treatment of HIV, where a cocktail of anti-retroviral drugs can slow down the replication of the virus thereby enabling people to live with the infection until old age. If they develop resistance to one drug, they are moved to another one. This is how HIV has turned from a lethal condition to a chronic condition.

This new perspective has provided fertile ground for the growth of new classes of cancer therapies. Newer drugs are more like smart bombs, though expensive. Some target communication signals with the malignant cells, some cut off supply lines by interfering with the growth of blood vessels around a tumour, and others block

the chemical agents that enable tumours to expand into new territory. These more targeted therapies tend to focus on frantically proliferating cancer cells while leaving healthy cells in tact. Drugs like Avastin inhibit the formation of new blood vessels around cancer cells starving them of nourishment. Signal blockers like Everolimus interrupt communication among enzymes that regulate growth and development of a cancerous cell. Hormone blockers like Tamoxifen, useful in certain types of breast cancer, keep cells from dividing by binding to oestrogen (a general term for female sex hormones) receptors. Growth-factor inhibitors like Herceptin block a cancer cell's link to crucial proteins that help it divide and grow. However, none of these advances mean that living with cancer is easy. A certain number of patients do not respond to any of the current treatments. Some types of cancer, especially, pancreatic, ovarian and stomach, continue to have high mortality rate. Side effects, however, remain an issue, despite the anti-nausea medications now being very good.

Despite the progress in the cancer therapy, it is imperative that we put in efforts to reduce the burden of cancer. It can be done by implementing evidence-based strategies for cancer prevention, early detection of cancer and management of patients with cancer. The key risk factors for cancer are tobacco use, being overweight or obese, low fruit and vegetable intake, physical inactivity, alcohol use, sexually transmitted infections such as HIV and HPV, urban air pollution, and indoor smoke from household use of solid fuels. Prevention strategies would obviously include avoidance of these risk factors. Next, it is necessary to educate and help people recognise early signs of cancer and seek prompt medical attention for symptoms, which might include lumps, sores, persistent indigestion, persistent cough, and so on. Education is also required to identify cancer early before signs are recognisable. We may then be able to live with the enemy, if not exterminate it.

□ **Vinay B. Kamble**

Recent Developments in Science and Technology

□ Biman Basu

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Why is Martian atmosphere so thin?

Mars is one of the three rocky planets of the solar system that has a substantial atmosphere, the other two being Venus and

Now scientists seem to have an answer.

According to David Brain of University of California, Berkeley, who recently presented the findings of the study of data gathered by the *Mars Global Surveyor*

is in the form of magnetic 'umbrellas' that sprout out of the ground and reach beyond the top of Mars' atmosphere. These umbrellas number in the dozens and they cover about 40% of the planet's surface, mainly in the southern hemisphere.

From the analysis of data from *MGS's* particles and fields sensors, gathered over 25,000 orbits, Brain's team discovered that occasionally the umbrella-shaped Martian magnetic field linked up with the magnetic field in the solar wind and "the joined fields wrapped themselves around a packet of gas at the top of the Martian atmosphere, forming a 'magnetic capsule' a thousand kilometres wide with ionised air trapped inside." The solar wind pressure then caused the capsule to 'pinch off' and it blew away, taking its cargo of Martian air with it. Brain's team has found more than a dozen examples of such transport of Martian air in magnetic capsules, which tend to blow over the south pole of Mars, mainly because most of the umbrellas are located in Mars' southern hemisphere.

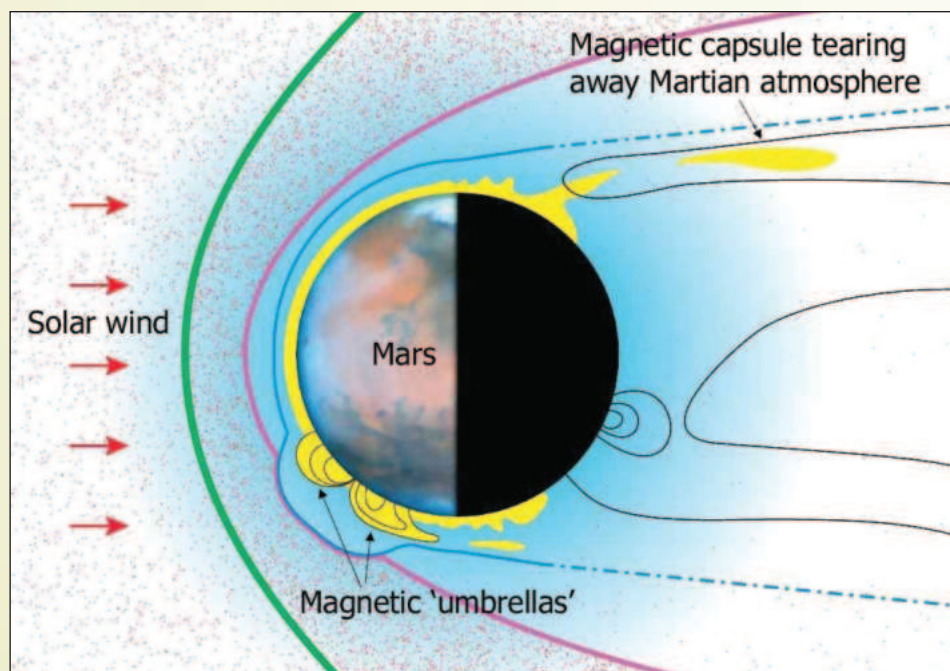


Diagram showing how Martian atmosphere may have been gradually stripped away by solar wind.

Earth. At present the Martian atmosphere is only about one-hundredth as dense as Earth's and is made up of mainly carbon dioxide, but researchers have found new evidence that the atmosphere of Mars was not always so thin. Some researchers believe, billions of years ago the atmosphere of Mars was as thick as Earth's. Ancient Martian lake-beds and river channels, as revealed by various space missions to the planet, tell the tale of a planet covered by abundant water and wrapped in an atmosphere thick enough to prevent that water from evaporating into space. Today, however, all those lakes and rivers are dry – the water having evaporated into space as a result of the super-low atmospheric pressure. What caused Mars to lose its atmosphere?

spacecraft at a workshop in Huntsville, USA, the atmosphere of Mars is being stripped away by solar wind. What is significant is that it is not continuous erosion, but rather a ripping process in which chunks of Martian air detach themselves from the planet and get lost into deep space. This surprising mechanism could help solve a longstanding mystery about the Red Planet.

The *Mars Global Surveyor* (*MGS*) was a US spacecraft launched by NASA in November 1996. It marked the United States' return to Mars after a 20-year absence. The mission was officially ended in January 2007. In 1998, *MGS* discovered that Mars has a very strange magnetic field. Instead of a global bubble, like Earth's, the Martian field

Extra-solar carbon dioxide detected

For the first time carbon dioxide has been discovered on a planet outside our solar system, lying about 63 light-years from Earth. The new extra-solar planet is a gaseous body slightly bigger than Jupiter, but it orbits so close its parent star that it should be far too hot to support life. But the finding does indicate the possibility of ultimately detecting carbon dioxide and other potential markers of life on planets that do lie far enough from their parent stars to be habitable.

The discovery was made by Mark Swain of NASA's Jet Propulsion Laboratory and his colleagues using the Hubble Space Telescope's Near Infrared Camera and Multi-Object Spectrometer. They recorded infrared spectra from the planet, which

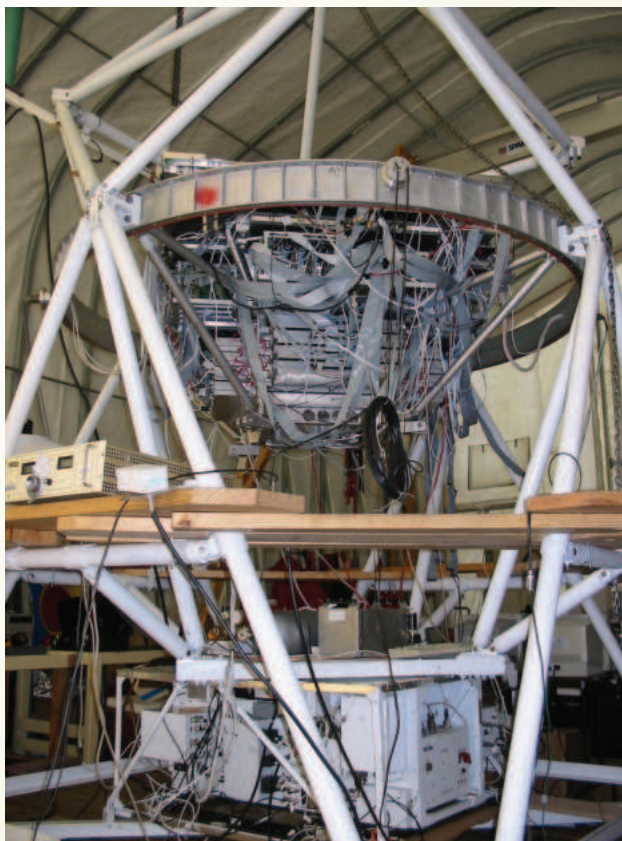
periodically transits, or crosses in front of, its parent star as seen from Earth. When the hot planet lies side by side with its parent star, identified as HD 189733, astronomers can detect the spectra of infrared radiation, or heat, from both star and planet. When the planet goes behind the star, only the infrared radiation from the star reaches Earth. Subtracting the two measurements gives the amount of infrared radiation given off by the planet alone. From the spectra of the planet's radiation recorded by the Hubble instrument, the team also found evidence of water vapour, which was previously detected in the planet's atmosphere, as well as carbon monoxide.

According to the researchers, one explanation for the carbon dioxide is the close proximity of the planet to its parent star that makes it receive an unusually high dose of ultraviolet light from the star. The intense ultraviolet radiation could have altered the chemical composition of the planet's atmosphere, breaking down compounds and creating new ones including carbon dioxide. Ultraviolet light from the Sun is believed to have triggered complex chemical reactions in Earth's early atmosphere.

With this discovery, three of the four key biomarkers for habitable/inhabited worlds – water, methane and now carbon dioxide – have now been detected outside the solar system. The only one remaining to be detected is oxygen.

Dark matter as cosmic ray source?

High-energy electrons captured over Antarctica could reveal the presence of a nearby but mysterious astrophysical object that is bombarding Earth with cosmic rays, but it could also be the long-



The ATIC payload without its cover (Photo: Seth White).



Balloon-borne ATIC detector being readied for launch in Antarctica (Photo: Seth White).

awaited physical evidence of elusive dark matter, as revealed by a recent study.

Cosmic rays are high-speed particles – either atomic nuclei or electrons – that travel at the speed of light throughout the Milky Way Galaxy, including the solar system. Some of these particles originate from the Sun, but most come from sources outside the solar system and are known as galactic cosmic rays. Cosmic-ray particles that arrive at the top of the Earth's atmosphere are termed primaries; their collisions with atmospheric nuclei give rise to secondaries. About 0.25% of cosmic ray particles are nuclei of light elements such as lithium, beryllium and boron but in far greater abundance than they are found in the universe, which is only about one in a billion. Nuclei of medium elements such as carbon, nitrogen, oxygen and fluorine are about 10 times as abundant as in normal matter, and the amounts of the heavier element nuclei are about a hundred times that in normal matter. This suggests an origin of cosmic rays in areas of space with greatly enriched amounts of heavy elements.

Since 1938, when French physicist Pierre Auger discovered cosmic rays, their origin has remained a long-standing mystery in contemporary astrophysics. According to one theory, cosmic rays are hurled through space to such great speeds by the shock waves of exploding stars called supernovae. But a new study using a balloon-borne particle collector called the Advanced Thin Ionization Calorimeter (ATIC) over Antarctica shows an unexpected surplus of cosmic ray electrons at very high energy

– ranging from 300 up to 800 billion electron volts (GeV) – that cannot be explained by the supernova theory. According to the researchers from Louisiana State University, USA, who conducted the study, such high-energy cosmic ray particles must be coming from a previously unidentified and nearby source. Such a source could be an unseen astrophysical object such as a pulsar or micro-quasar that accelerates electrons to those energies or the electrons could arise from the annihilation of dark matter particles (*Nature*, 20 November 2008).

According to the researchers, this mysterious source would need to be within about 3,000 light-years of the Sun to account for the observed energies. One possibility of such a source could be an exotic object such as a pulsar, mini-quasar, supernova remnant, or an intermediate-mass black hole. But that possibility appears remote, as there are few such objects close to our solar system. An alternative explanation provided by the researchers is that the high-energy electron surplus might result from the annihilation of very exotic particles put forward to explain dark matter, which is believed to be five times more common than visible matter in the universe, but there is no proof of what it is made of. The ATIC results may be the first physical evidence of elusive dark matter or an indication of a very interesting object near our solar system waiting to be studied by other instruments.

The existence of dark matter has largely been inferred from its gravitational effects, such as the fact that most galaxies have enough mass to remain as well-defined objects despite having too little visible matter to account for the necessary gravity. A few exotic particles have been suggested as dark matter ingredients. One of these, named the ‘Kaluza-Klein’ particle, is predicted to have the same mass as 550 to 650 protons. When these theoretical Kaluza-Klein particles collide and annihilate, they are expected to produce electrons with energies between 550 and

650 GeV, in the same range as detected by ATIC.

The 2,100-kg ATIC detector is designed to measure the energy spectrum of individual cosmic ray elements. It was carried to an altitude of about 38 kilometres above Antarctica using a huge helium-filled balloon. The goal was to study cosmic rays that otherwise would be absorbed into the atmosphere. Circular winds at the latitude of Antarctica allowed the balloon to stay aloft for up to 30 days at a time, capturing electrons and measuring their charges, energies, and trajectories.

Photosynthesis with stolen genes

That green plants can produce their own food by photosynthesis using sunlight is common knowledge. But if someone claims that an organism can acquire the ability to photosynthesise simply by eating plants one would laugh at it. But it is true; one animal – a sea slug that lives along the Atlantic seaboard of the United States – does just that. The sea slug *Elysia chlorotica* gets its ability to use sunlight for photosynthesis by using genes “stolen” from the algae it eats (*Proceedings of the National Academy of Sciences*, 18 November 2008).

Mary Rumpho of the University of Maine, an expert on *E. chlorotica*, was aware of the fact that the sea slug acquires chloroplasts – the green cellular objects that allow plant cells to convert sunlight into energy – from the algae it eats, and stores them in the cells that line its gut. It was also known that young *E. chlorotica* fed with algae for two weeks, could survive for the rest of their year-long lives without eating (by photosynthesising their own food using sunlight). But the question remained as to how the slug could manage with chloroplast DNA alone that encoded for only about 10% of the proteins needed for photosynthesis. The other necessary genes are found in the algae’s nuclear DNA.

The answer was provided by Rumpho’s latest experiments, in which she and her colleagues sequenced the



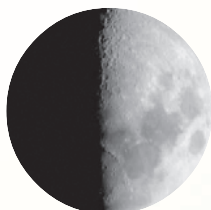
Elysia chlorotica

chloroplast genes of *Vaucheria litorea*, the alga that is the sea slug’s favourite food. They confirmed that if the sea slug used the algal chloroplasts alone, it would not have all the genes needed to photosynthesise. But when they analysed the sea slug’s own DNA they found one of the vital algal genes was present and its sequence was identical to the algal version. How could the algal gene get into the sea slug’s DNA? According to the researchers the slug had probably ‘stolen’ the gene from its food – a phenomenon known as kleptoplasty.

The researchers suggest that, as the algae are processed in the sea slug’s gut, the gene is taken into its cells along with the chloroplasts. The genes are then incorporated into the sea slug’s own DNA, allowing the animal to produce the necessary proteins for the stolen chloroplasts to continue working. Another possibility could be that a virus found in the sea slug carries the DNA from the algal cells to the sea slug’s cells. However, there is no evidence for this yet.

Sky Map for January 2009

Moon - First Quarter



4 January

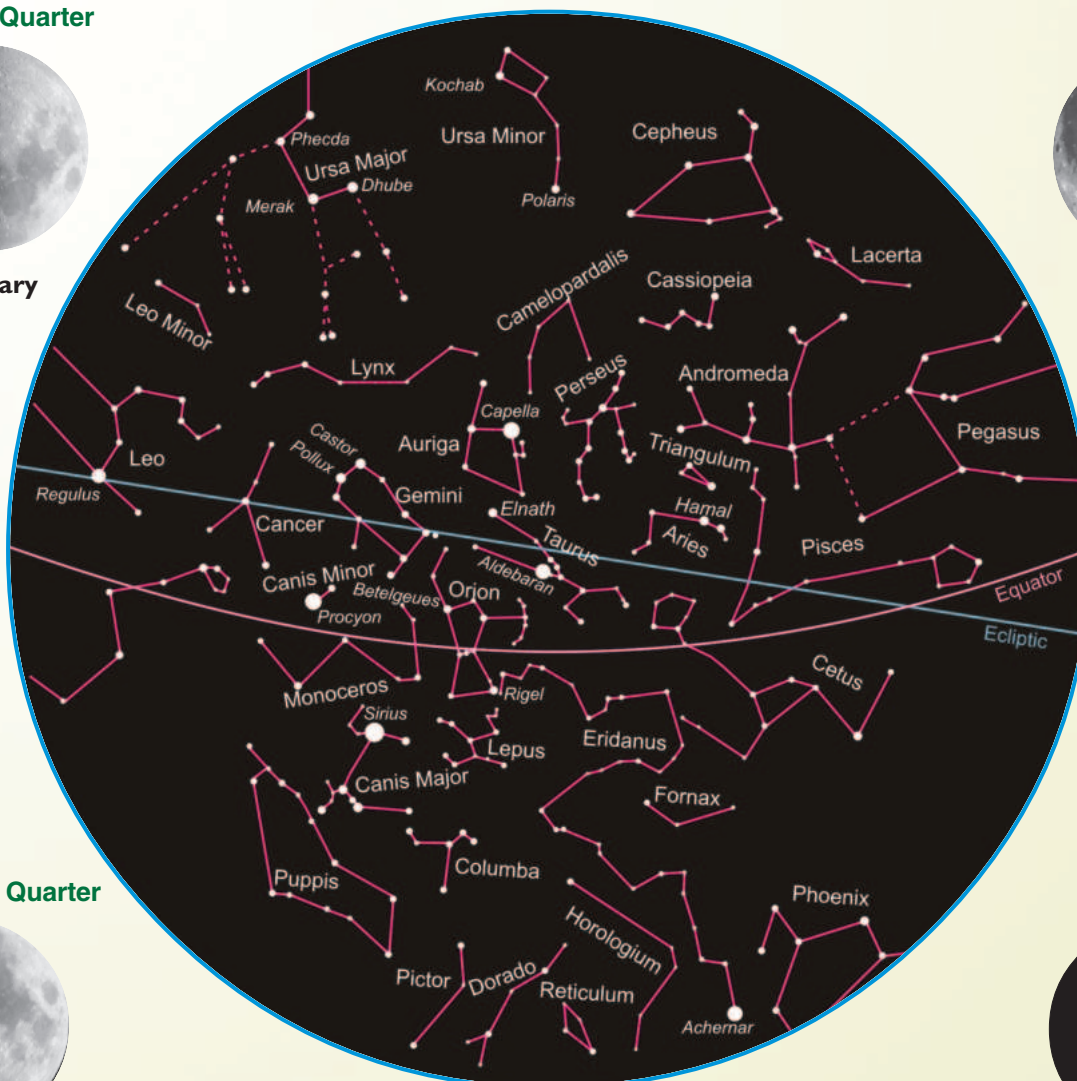
Full Moon



11 January

East

West



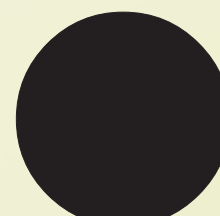
South

Moon - Last Quarter



18 January

New Moon



26 January

The sky map is prepared for viewers in Nagpur (21.090 N, 79.090 E). It includes Constellations and bright stars. For viewers south of Nagpur, Constellations of the southern sky will appear higher up in the sky, and those of the northern sky will appear nearer the northern horizon. Similarly, for viewer north of Nagpur, Constellations of northern sky will appear higher up in the sky, and those of the southern sky will appear nearer the southern horizon. The map can be used at 10 PM on 1 January, at 9 PM on 15 January and at 8 PM on 31 January.



Tips to use sky map:

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

Visibility of Planets*

	Rising	Setting	In the Zodiac
Mercury	07:33	18:41	Capricornus-Sagittarius
Venus	09:38	21:21	Aquarius-Pisces
Mars	06:13	17:00	Sagittarius
Jupiter	07:23	18:22	Sagittarius-Capricornus
Saturn	21:54	10:17	Leo
Uranus*	10:03	21:51	Aquarius
Neptune*	08:36	19:54	Capricornus

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

Sky Event

Date	IST	Event
04	19:29	Mercury at Greatest Elongation (E)
04	19:29	Earth at Perihelion
10	16:22	Moon at perigee
15	04:29	Venus at Greatest Elongation (E)
23	05:41	Moon at Apogee
26	13:29	Annular Solar Eclipse
30	17:08	Venus 3° South of Moon

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



Vigyan Prasar

New Publication and Activity Kits from Vigyan Prasar

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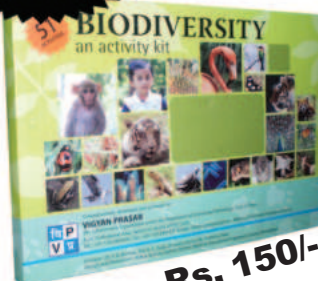
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ACTIVITIES



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Vigyan Prasar has brought out two activity kits on "Biodiversity" and "Weather". Each kit comprises of hands-on activities illustrating scientific principles and the natural phenomena and processes, which are self explanatory.

The scientific concepts, information and principles, phenomena and dynamics of natural processes relating to Weather and Biodiversity can be studied/learnt through the hands-on activities given in the kits.



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ACTIVITIES

Rs. 150/-

For more details please write to :-

Director

VIGYAN PRASAR

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International Year of Astronomy 2009

It is desirable that the citizens of the world rediscover their place in the Universe through the day and night time sky, and thereby engage a personal sense of wonder and discovery. It is important that all human beings realise the impact of astronomy and basic sciences on our daily lives, and understand better how scientific knowledge can contribute to a more equitable and peaceful society. This is why the United Nations in its 62nd General Assembly proclaimed 2009 as the International Year of Astronomy (IYA 2009), with the central theme "The Universe, Yours to Discover".

Vigyan Prasar has chalked out an ambitious campaign for various target groups. The details of the activities undertaken/ to be undertaken by Vigyan Prasar as part of its outreach campaign are given below.

Outreach Programmes: International Year of Astronomy 2009

- **Radio Serial on Astronomy** : Production and broadcast of a 52 - episode radio serial on astronomy in 19 major Indian languages including English.
- **Television Serial on Astronomy** : Production and telecast of a 26 episode television serial on astronomy in Hindi. The programme would be telecast from the National Channel of Doordarshan on Sunday morning in the slot 0900-0930 hrs. Later, the 26 episodes would be dubbed into 12 major Indian languages and telecast from the regional Doordarshan Kendras (TV Stations) through regional network of Doordarshan spread in the country.
- **Publications** : Publication of about 10 titles at popular level on various topics of astronomy in English and Hindi. These titles would be translated into other Indian languages later on.
- **Activity Kit** : Development of a low cost activity kit-cum-educational package containing 25-30 activities on basic aspects/phenomena of astronomy. The activity kit would be brought out in English and Hindi. This has already been developed, and contains a safe solar-viewer.
- **Demonstrations** : Lecture / demonstrations on various aspects of astronomy in association with Scientists / organizations working in the field of astronomy / astrophysics.
- **Training** : Training programmes for resource persons from different regions / states of India. The trained resource persons would in turn train more communicators in their states / provinces, deliver talks and conduct activities on popular aspects of astronomy.
- **Workshops** : Telescope making workshops would be organized in different parts of the country.

YOUR OPINION

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

This month's topic:

India plans to send a manned mission to space in near future. How in your opinion will this mission benefit Indian Science and Technology?

Response should contain full name; postal address with pincode and email ID, if any; and should be accompanied by a recent passport size photograph. Response may be sent by email (opinion@vigyanprasar.gov.in) or by post to the address given below. If sent by post, "Response: *Dream 2047* January 2009" should be clearly written on the envelope.



Vigyan Prasar

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Letters to the Editor

Management of OCD

I read the article by Dr Yatish Agarwal (October 2008). If we are able to understand the status of mind scientifically we will be able to cope with all these problems more effectively. Mind and brain are two distinct things. Brain is an anatomical entity whereas mind is a functional entity. Mind can be defined as the function of the autonomic nervous system (ANS). It is claimed that mind can be brought under conscious control through the practice of meditation. But how? ANS is largely under the control of the hypothalamus, which is situated very close to optic chiasma (the X-shaped structure formed at the point below the brain where the two optic nerves cross over each other). Protracted practice of concentrating at this region during meditation can bring functions of ANS, say mind, under one's conscious control.

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An informative magazine for students

For the first time, I have got the chance to go through the *Dream 2047* magazine that covers topic on relevant issues in science and technology. The article 'Alcoholism: Recognising when you are hooked' by Dr Yatish Agarwal (December 2008) was very informative, and educative as well. I would like to congratulate the *Dream 2047* team for publishing such a good magazine. It will be more helpful if this magazine is made available in the universities and colleges for the benefit of the student community as a whole.

Jhumpa Dey (Sarkar),
Karimganj, Assam