



Vigyan Prasar

DREAM 2047

September 2011

Vol. 13

No. 12

Rs. 5.00



Carl
Graebe



(1841-1927)

J. F. Wilhelm
Adolf von Baeyer



(1835-1917)

August Wilhelm
von Hofmann



(1818-1892)

Carl Theodore
Liebermann



(1842-1914)

Otto Nikolaus
Witt



(1853-1915)

The Colourful World of Dyes and Pigments



Inside

<i>Editorial: Unchallenged Abuse of Mass Media</i>	43
<i>The Colourful World of Dyes and Pigments</i>	42
<i>Astrochemistry : The Chemistry of Space</i>	38
<i>Conversation with Dr. Neelima Jerath</i>	35
<i>The Spectrum of Autism: All You Want to Know About</i>	32
<i>Recent Developments in Science and Technology</i>	28
<i>VP News</i>	25

Unchallenged Abuse of Mass Media



Turning on lights in all rooms of one's house ensures that the goddess of the wealth visits and leaves behind a fortune. This works best on Diwali evening. The wailing of a dog is a sure signal that the Great Reaper is visiting the neighbourhood and bad news will soon follow. A widow, even if she is in position of power, is inauspicious and major engineering projects have been inaugurated with religious fervour by a married lady before the formal function.

Some trees are sacred. Some animals are inauspicious. Some days are not recommended for eating meat, chicken or meat preparations. Itching of the right eye is good for men and itching of the left eye for women. Conversely, itching of the other eye forewarns of bad news.

This is just a sample of the current myths and superstitions that abound in our society. These hamper efficiency and productivity and sometimes result in situations that are ludicrous. These are selectively used for pampering our vast range of god men and in the process disempowering the believers – weak and ignorant.

Mass media has a significant role in encouraging rationality and developing scientific temper. With increasing reach and better accessibility it can discourage mysticism and promote analytical thinking. With increase in levels of literacy, superstitions (harmless and dangerous) are bound to reduce in importance to become the subject of satire and comedy.

Some media houses have, however, positioned their presentations and reports in a manner which encourages dogmatism and irrational beliefs. This has become their USP (unique selling proposition) ensuring dedicated viewership and corresponding rates for commercial time. The impact on the viewers (a large number being semiliterate) has not received due attention.

Vastu as a guide for a floor plan of a house, astrology and a whole host of other forecasting techniques to guide risk-takers and other pseudo-scientific knowledge systems find disproportionate space in both traditional and new media. The need to cover one's risks, particularly when the stakes are high, attracts a growing segment of the population to sacrificing rationality and seeking refuge in such mumbo-jumbo. Selective use of scientific terms and professional sounding anchors improves their credibility. Scientists are rarely on the show and if at all they are invited they are used very cleverly to strengthen the views of the astrologers. This abuse of the power of mass communication remains largely unchallenged.

There are exceptions amongst rationalists and they can be counted on one's fingertips. They challenge the purveyors of such mysticism and demonstrate the weaknesses of the miracle men. They generally do not get the same space or stage to do this. The vast majority of science teachers and researchers, planners and policy makers, most unfortunately, continue to be passive observers and thus are doing great damage to their own credibility.

Responsible print media houses and television channels must demonstrate commitment to rational thought, knowing the dismal levels of public understanding of science, and make deliberate positive efforts at encouraging reasoning and use of logical processes, and making people aware of the ill effects of superstitions.

Vigyan Prasar and other institutions mandated to stimulate scientific temper have the responsibility for countering claims by frauds and exposing the truth behind natural phenomena as well as supporting victims of myths and superstitions. Legal remedies must be examined to stop the runaway programmes and ensure adequate opportunities for countering claims and exposing the myths. This task will become less daunting if support is received from academia and researchers in science, technology, philosophy, sociology, juridical science, management studies and mass communication.

Are you willing to step forward and be counted?

□ Anuj Sinha

E-mail: sanuj@vigyanprasar.gov.in

Editor : Er Anuj Sinha
Address for correspondence : Vigyan Prasar, C-24, Qutab Institutional Area, New Delhi-110 016
Tel : 011-26967532; Fax : 0120-2404437
e-mail : info@vigyanprasar.gov.in
website : <http://www.vigyanprasar.gov.in>

Vigyan Prasar is not responsible for the statements and opinions expressed by the authors in their articles/write-ups published in "Dream 2047"

Articles, excerpts from articles published in "Dream 2047" may be freely reproduced with due acknowledgement/credit, provided periodicals in which they are reproduced are distributed free.

The Colourful World of Dyes and Pigments



Dr. Subodh Mahanti

E-mail: smahanti@vignyanprasar.gov.in

“Many natural dyes have been known for a long time. These were obtained from animal and vegetable sources. Today, however, practically all dyes are synthetic and are prepared from aromatic compounds, the only source of which, until recently, was coal-tar; hence the name coal-tar dyes.”

I. L. Finar in *Organic Chemistry, Vol.I: The Fundamental Principles (Third Edition)*, 1959

“The synthetic dye industry, which reached maturity in the last third of the nineteenth century, was the basis and nucleus for the entire fine chemicals industry. Many of the largest dye companies diversified early into other products, such as pharmaceuticals, photochemicals, food chemicals, pesticides, organic intermediates, heavy chemicals, plastics, and all other products of chemical industry. The dye industry also claims pride of place in the origin of industrial research laboratories.”

J. Rocke in *The Oxford Companion to the History of Modern Science*, edited by J. L. Heilbron, Oxford University Press, 2003.

Dyes (also called dyestuffs) and pigments are the substances used to impart colour to a material. These substances are an integral part of life. The presence of these substances can be observed everywhere.

There is no doubt that, humans in all parts of the world since the earliest times took delight in the vivid colours that they found in their environment. They were not simply content by observing the different colours but they also tried to find ways to capture the colours for permanent possession and use. This earliest desire to capture colour led human beings to discover newer and newer dyes and pigments. It can

be reasonably assumed that early attempts were not successful, but repeated trials and errors eventually led to perfecting the use of dyes and pigments.

Colour has been an integral part of human culture for thousands of years. Early humans in all parts of the world extracted dyes and pigments from the natural environment to decorate themselves, their clothing and items used in everyday life. They also used colour to convey symbolic and religious ideas. Early humans painted their bodies, masks, totems, and dwelling places of other important objects. They believed such designs and symbols would protect them against evil

forces and they also considered such acts as a means of purification and preparation for participation in ceremonies. In many places colours were used to establish clan and tribe distinctions.

The art of dyeing was developed in every region of the planet Earth. That early humans used colour extensively is evident from the presence of colours in ancient textiles, pottery, funeral remains, implements and rock art. The presence of red ochre has been discovered in 3500-year-old burial site in Europe. People of each culture used colour in their own unique way based on their belief systems and the resources available.

Before synthetic dyes were available some colours were very costly; for example, blue and purple, which came to be associated with royalty or wealthy class. Tyrian purple, a pigment made from the mucus of one of several species of Murex snail was very expensive. In fact one of the most important ancient Greek historians Theopompus of Chios (ca.378-ca.320 BC) is believed to have reported that “purple for dyes fetched its weight in silver in Colophon (in Asia Minor)”. The only way to achieve a deep rich blue was by using a semi-precious stone lapis lazuli to produce a pigment called ultramarine. But the best sources of lapis were very scarce.



Caption

Difference between dyes and pigments

Though both dyes and pigments are used to impart colour to other materials, there are some basic differences between dyes and pigments as indicated below:

- Dyes are coloured substances that exhibit affinity to the substrate to which it is applied. Dyes are usually applied in aqueous solution and some dyes (called mordant dyes) require a mordant (a substance that aids in the dyeing process) to improve colour fastness. Dyes may be liquid or solid. Pigments are usually solids and they

impart colour by changing the colour of the reflected or transmitted light resulting from selective absorption of a particular wavelength. Pigments have no affinity to fibres and they need other modifiers to increase affinity to fibres.

- Dyes are usually soluble or they can be made soluble in water but pigments are generally insoluble in water.
- Many dyes, particularly the lower dyes, are vulnerable to light. On the other hand pigments are considered less vulnerable to light.
- Dyes are available in large numbers and comparatively pigments are in lesser number.
- During the dyeing process the dye molecules may undergo structural changes, but pigments retain their original structures
- The particles of dyes are much smaller than those of pigments.
- Dyes are generally organic in nature but pigments may be both inorganic and organic.
- While dyes are extensively used in dyeing, pigments are widely used in printing.

Compared to pigments dyes are expensive.

The basis of colour

Ancient people were fascinated by colours in their environment and also found ways and means to capture them. However, it was not possible for them to explain the basis of colour. The question what make some molecules coloured and some others not could be tackled only after the growth of scientific knowledge.

In 1868, German chemists Carl Graebe (1841-1927) and Carl Theodore Liebermann (1842-1914) observed that coloured organic compounds could be converted into colourless compounds by reduction and the original colour could be restored by removing the hydrogen atoms (added by the reduction process) by oxidation. Otto Witt, another German chemist proposed a theory of colour in 1875. According



Carl Graebe

to Witt, colour usually appears in an organic compound if it contains certain unsaturated groups; that is, groups with multiple bonds. For example, two simplest organic compounds glyoxal ($O=HC-CH=O$) and diazomethane ($H_2C=N=N$), which are coloured, have double bonds. The reduction products of both glyoxal and diazomethane are colourless. Witt called the groups containing multiple bonds chromophores and the compounds containing the chromophoric group chromogens. Some important chromophores are: carbonyl ($C=O$), nitroso ($N=O$), azo ($N=N$), azoamino ($N=N-NH$), and thiocarbonyl ($C=S$). It was observed that the depth of colour increases with the number of chromophores. Witt also found out that the presence of certain groups like hydroxyl ($-OH$) and amino ($-NH_2$) in the chromogen deepens the colour though they are not chromophores. Witt called such groups auxochromes, which are usually acidic or basic.

There are some radicals which bring about deepening of colour, and there are some others which do the opposite. The radicals which deepen colour are called bathochromic groups and the radicals that bring about the opposite effect are called hypsochromic groups. By deepening colour it is meant that colour changes from yellow → orange → red → purple → violet → blue → green → black.

Today we know that when something is coloured it means that it either reflects or absorbs electro-magnetic radiation in the visible spectrum, the only narrow region in the entire electro-magnetic spectrum which our eyes can detect. This range falls in the region of 360-780 nanometres (nm), the effective range being 380-720 nm. (1



Carl Theodore Liebermann



Otto Nikolaus Witt

nm = 1 billionth of a metre.) Below 360 nm the ultra-violet region begins and above 780 nm, the infrared region starts. Dyes and pigments change the colour of reflected or transmitted light as the result of selected absorbance of certain wavelengths. When this absorbance falls in the visible spectrum, then the reflected or transmitted light becomes deficient in a particular colour and the surface appears coloured. This physical process is different from fluorescence, phosphorescence, and other forms of luminescence caused by emission of light by the materials. Seven colours namely violet, indigo, blue, green, yellow, orange and red make up the white colour — the sunlight. When a light source is deficient in any colour, the light appears to be coloured in the complementary colour as shown below:

Colour absorbed	Complementary (visible) colour
violet	yellow-green
blue	yellow
green-blue	orange
blue-green	red
green	purple
yellow-green	violet
yellow	blue
orange	green-blue
red	blue-green

A substance will appear yellow because it absorbs the blue portion of the spectrum only or it absorbs the entire visible spectrum except yellow. In practice no dye gives a pure shade because it does not absorb only one colour, it may absorb other colours to a small extent.

When a molecule absorbs light it undergoes transition from a lower energy state to a higher energy state. Absorbed energy (ΔE) can be expressed as $E_2 - E_1 = h\nu$, where E_2 is the higher energy state, E_1 is the original energy state, h is Planck's constant, and ν is frequency of the absorbed

light. When the molecule is monatomic the absorbed energy raises the atom from its ground state to some excited state. However, in case of molecules containing more than one atom the absorbed energy may bring about changes in electronic, vibrational and rotational energy. ΔE is large for changes in electronic states as such changes are associated with large amounts of energy compared to vibrational and rotational changes. When ΔE is large ν becomes small and consequently the wavelength becomes long (as frequency is inversely proportional to wavelength). This means changes in electronic states result in absorption or emission in the visible or ultraviolet regions of the spectrum and rotational and vibrational energies in the far and near-infrared regions.

When we deal with colours we are only concerned with the visible region. It is to be noted that ΔE has definite values as an electron must occupy some particular orbital. The absorption spectrum of complex molecules with multiple bonds will produce a spectrum consisting of bands where the spectral lines are very close together owing to the values of ΔE being very close. These bands in certain regions of visible light give rise to colour. The deepening of the colour depends on the conjugation in a molecule — the longer the conjugation the deeper is the colour. The effect of conjugation results from the increase in the number of electrons involved in the oscillation of the molecules. A conjugated system is a connected system of p-orbitals with delocalised electrons in compounds with alternating single and multiple bonds, which leads to lowering of overall energy of the molecules and increase stability. Auxochromes enhance the colour of the chromogens by enhancing conjugation.

Hue refers to the distinctive characteristics of a given colour that enable it to be assigned a position in the spectrum. The hue may also be interpreted as a particular shade or tint of a given colour. There are about 150 hues that can be distinguished in the visible spectrum. White light dilutes the wavelengths which give a particular surface its hue and so the strength of a surface colour is inversely proportional to the amount of white light that it reflects.

The brightness of a dye depends on the shape of the absorbance band. The dye is bright if the band is narrow and sharp. In case of a broad absorbance band a dye becomes

dull because the dye absorbs wavelengths other than the one that causes its hue.

Natural dyes

The use of dyes for textile dyeing can be traced back to the Neolithic period. The dyes used were natural dyes — dyes derived from natural objects like plants, invertebrates or minerals. For thousands of years humans were dependent on natural dyes. The majority of natural dyes are vegetable dyes. In archaeological sites, surviving textile fragments and dyes have been found and based on these archaeological evidences it has been concluded that red, blue and yellow dyes derived from plant sources were in common used by the late Bronze Age and the Iron Age. Textiles may be dyed as raw fibre, as spun yarn, or after weaving (piece-dyed).

The majority of natural dyes require a mordant; that is, a chemical to help 'fix' the colour on the fibre. By using different mordants it is possible for a dyer to obtain a variety of colours and shades from the same dye. Some of the early mordants used were vinegar, tannin from oak bark, ammonia from stale urine, and wood-ash liquor or potash (potassium carbonate) made by leaching wood.

Red dyes can be obtained from a variety of plants including lichens, henna, alkanet or dyer's bugloss, asafoetida, and madder. Turkey red, a strong, very fast red dye for cotton, was developed in India and spread to Turkey. Munjeet or Indian madder (*Rubica cordifolia*) is native to Himalayas and other mountains of Asian countries.

Yellow dyes can be extracted from saffron, pomegranate rind, turmeric, safflower, onion skins, and a number of weedy flowering plants. Even before the Iron Age, weld (*Reseda luteola*), also called mignonette or dyer's rocket was used to produce yellow dye.

Blue dyes were produced from indigo dye-bearing plants, primarily those in the genus *Indigofera*, found in tropical countries. The primary commercial indigo species found in Asian countries was true indigo (*Indigofera tinctoria*). India was the oldest centre of indigo dyeing and it supplied indigo dye to Europe as early as the Greco-Roman

era. In fact the Greek word for the indigo dye, 'indikon' reflected India's early association with the dye. The term 'indicum' was used by the Romans for the indigo dyes, which eventually passed into English as 'indigo'.

Plants yielding green dyes are not very common. Both woad and indigo have been used since ancient times in combination with yellow dyes to produce shades of green.

An ancient brown dye called cutch derive from acacia trees particularly *Acacia Catechu* used in India for dyeing cotton. Different shades of brown were produced by using cutch in combination with mordants; for example, grey browns with iron as mordant and olive browns with copper.

Wearing black garments were fashionable in Middle Age Europe. However, producing a black colour was really a complicated process involving multiple dyeing with woad or indigo followed by mordanting.

Lichens produced a verity of greens, oranges, yellows, reds, browns, bright pinks and purples.

Industrial dyes

Aniline purple was the first industrial dye to be produced. It was discovered in 1856 by the English chemist William Henry Perkin (1838-1907), a student of the August Wilhelm von Hofmann (1818-1892) at the Royal College of London (now part of Imperial College, London). It was an accidental discovery. Perkin was experimenting with crude aniline derived from coal tar. He started commercial production of aniline purple and made a fortune. The dye became fashionable as "mauve" in France and in other countries as Mauveine.

Perkin's success ushered in a commercial revolution. In 1859, a French dye farm introduced a new aniline-derived

colour. It came to be known as magenta (except France where it was called "fuchsine". Magenta became so popular that soon it replaced mauve. By 1862, more than a dozen coal-tar colours were introduced in the market. It should be noted that picric acid is really the first synthetic dye, which was synthesised by the Irish chemist Peter Woulfe (1727-1803) in 1771. Picric acid is a fugitive dye. Perkin's



William Henry Perkin

synthesis of Mauveine founded the synthetic coal-tar industry and so Mauveine is considered as the first synthetic dye.

In 1869, Carl Graebe and Carl Liebermann were successful in synthesising alizarin, the first important natural dye. Soon after, it was produced commercially on a large scale, which led to the destruction of extensive madder plantations in Provence and Turkey.

In 1880s, the German chemist Johann Friedrich Wilhelm Adolf von Baeyer (1835-1917) succeeded in synthesising indigo. However, its commercialisation undertaken by BASF proved to be difficult and it could be achieved in 1897 after spending more than three million Marks.

After the above mentioned initial path-breaking successes, different industrial dyes were produced. Dye industry not only expanded beyond imagination but it also helped bring about industrialisation of other chemicals.

Classification or types of dyes

Dyes are usually classified according to the way in which the dye is applied or is used on the substance because this kind of classification is important to the dyer. The important classes of dyes based on their application are given below:

Substantive dyes: Also called direct dyes, substantive dyes have a high affinity for cotton, rayon and other cellulose fibres. These dyes are applied directly from a neutral or slightly alkaline bath containing sodium chloride or sodium sulphate. These dyes are called 'substantive dyes' because they are distinguished by their greater affinity for the substrate. Substantive dyes are also used as pH indicators or biological stains.

Vat dyes: Vat dyes are practically insoluble in water and so they cannot be applied directly to fibres. However, these dyes can be converted into water-soluble forms (the so-called leuco forms of the dyes) by reduction. The water-soluble forms of vat dyes have affinity for flexible fibres. Indigo



August Wilhelm von Hofmann



Johann Friedrich Wilhelm Adolf von Baeyer

and anthraquinone are examples of vat dyes.

Mordant dyes: These dyes are called mordant dyes because in the dyeing process the dyes require a mordant. Mordants are often inorganic oxides or salts, which are absorbed on the fabric. The dyes then form a coloured complex with the mordant. The final colour is dependent on both the mordant and the dye. By using a different mordant the final colour can be changed significantly. About thirty percent of the total dyes used for wool are mordant dyes, which are particularly useful for black and navy blue shades.

Acid dyes: These dyes can be used for protein fibres; for example; wool and silk and for polyamide and acrylic fibres. They are applied to fibres using neutral to acid dye baths. Salt formation between anionic groups in

the dyes and the cationic groups in the fibre is believed to be partly responsible for the attachment of such dyes to the fibre. In acid dyes the chromophore is part of a negative ion (anion) usually an organic sulphonate, RSO_2O^- . Metallised dyes are forms of acid dyes in which negative ion contains a chelated metal atom. Most of the synthetic food colours fall in the category of acid dyes.

Basic dyes: These dyes have chromophores that are part of a positive ion (cation). Basic dyes are water soluble. Usually acetic acid is added to the dye bath to help the uptake of the dye onto the fibre. They are mainly used for acrylic fibres and also for wool and silk. They are also used in the colouration of papers.

Reactive dyes: These dyes have a chromophore attached to a substituent, which is capable of directly reacting with the fibre substrate. They are by far the best choice for dyeing cotton and other cellulose fibres at home. "Cold" reactive dyes like Procion MX, Cibacron F, and Drimarene K can be applied at room temperature. Reactive dyes are attached to natural fibres by covalent bonds and because of this fact they are

among the most permanent of dyes.

Disperse dyes: These are insoluble dyes which are applied in the form of a fine dispersion in water. Dispersive dyes are mainly used for dyeing polyester but they can also be used for dyeing nylon, cellulose triacetate, and acrylic fibres. Large surface area resulting from the very fine particle size aids uptake by the fibre. A particular dispersing agent can significantly influence the dyeing rate.

Azo dyes: An azo dye is produced directly onto or within the fibre by treating a fibre with both diazoic and coupling components. By adjusting the dye bath conditions suitably the components can be made to react to produce the required insoluble azo dye. The colour can be controlled by proper selection of diazoic and coupling components. However, due to the toxic nature of the chemicals used the importance of azoic dyeing is declining.

Sulphur dyes: Sulphur dyes are absorbed by cotton from a bath containing sodium sulphide or sodium hydrosulphite and are made insoluble within the fibre by oxidation. During the oxidation process these dyes form complex molecules, which is the basis of their wash-fastness. Sulphur dyes are mainly used for dark colours such as black, brown and dark blue.

Food dyes comprise a class of dyes which describes the role of dyes rather than their mode of use. These dyes, which are known as food additives, are manufactured to a higher standard than industrial dyes. Both naturally occurring and synthetic dyes are used as food dyes and they may be substantive, mordant or vat dyes.

Some other classes have been established, viz., oxidation bases, laser dyes, leather dyes, fluorescent brighteners, solvent dyes, carbine dyes and contrast dyes.

Dyes can also be classified according to their chemical structures. However, it should be noted that the chemical constituents of dyes are so varied that it is not really feasible to classify them into distinct groups based on their chemical constituents. Some groups are indicated below:

Anthraquinone dyes: The chromophore for these dyes is a quinoid ring (a ring structure with two points at which chromophores can attach). Anthraquinone dyes are derived from anthracene. This class

Continued on page 33

Astrochemistry : The Chemistry of Space

The main theme of the International Year of Chemistry (IYC-2011) is “Chemistry – Our Life, Our Future”. The year 2011 is the centenary year of two major events of the scientific world, particularly the world of chemistry. One of these is the second Nobel Prize for Madam Curie (1867-1934) for her contributions in the field of chemistry and the other is the foundation of ‘International Association of Chemical Societies’ (which later came to be known as ‘International Union of Pure and Applied Chemistry’ or IUPAC). The main idea for declaring 2011 as the International Year of Chemistry is “to celebrate the art and science of chemistry and its pivotal contributions to our knowledge, to environmental protection, to improvement of health and to economic development”. In short, chemistry is the science of gaining correct knowledge about the internal structure and properties of matter. We, the inhabitants of Earth, reside within the solar system, which is again a tiny part of the vast Universe. All matter of the Universe is made of atoms and molecules. So, everything in this Universe comes under the purview of chemistry. Again, a large portion of the Universe is made up of various celestial bodies in space, viz., galaxies, stars, planets, satellites, dwarf planets, asteroids, comets, etc. Compositions of different celestial bodies, chemical reactions between those components, etc., all come within the area of chemistry.

What is astrochemistry?

Astrochemistry deals with various chemical substances present in space and their process of creations, destructions, and reactions. In fact, the common area of investigation in astronomy and chemistry is known as astrochemistry. More specifically, the branch of science which investigates the chemical compositions, chemical reactions and subsequent evolutions of planets, stars and vast spaces lying between two stars (known as interstellar space) is known as chemistry of space or astrochemistry. However, it should be remembered that the areas of science dealing with nuclear reactions, stellar evolution, etc., come within the common

field of investigation of both astrochemistry and astrophysics. Again, both astrochemistry and astrobiology investigate about the origin of life on Earth. On the other hand, that branch of astrochemistry which deals with the chemical substances present within solar system objects is known as cosmochemistry. As a result of seminal works of Harold Urey (1893-1981), Hans Sues (1909-1993), and Harrison Brown (1920-2003) in the 1940s regarding the origin and evolution of the solar system and presence of different chemicals in it, cosmochemistry originated as a branch of astrochemistry. In astrochemistry, our knowledge of chemistry is applied in areas of space having very small density and temperature. Molecules can be present in space at very low temperature (about 20 Kelvin) and pressure compared to the conditions on Earth. Moreover, chemical substances which are unstable under conditions prevailing on Earth can remain in stable conditions in space and make their presence felt through visible, infrared and ultraviolet regions of the electromagnetic spectrum. For instance, it has been possible to obtain protonated (i.e., having an extra proton) molecular hydrogen (H_3^+) in the conditions prevailing in space.

Discovery of chemicals in space

After the discovery of the laws of spectrum analysis by Gustav Kirchoff (1824-1887) and Robert Bunsen (1811-1899), a new horizon in space research was opened up. After analysing the spectrum of light from various known chemical elements found on Earth, it was found that the lines of every element differ from those of others. Using this knowledge, scientists started identifying various chemical elements present in a particular celestial body through spectroscopic analysis of light coming from that object and consequently astrophysics and astrochemistry were born as branches of astronomy.

During the total solar eclipse of 1868, French scientist Pierre Janssen (1824-1907) observed the spectrum of solar chromosphere from India. He noticed two bright yellow



Utpal Mukhopadhyay
E-mail: umsbv@yahoo.in

lines in that spectrum. Initially he considered those lines as due to sodium. Almost at the same time, British scientist Norman Lockyer (1836-1920) independently observed the same two yellow lines in the solar spectrum. Careful observations revealed that those lines were not due to sodium. Then it became clear that Janssen and Lockyer had discovered a new element not known to man. Keeping similarity with the word *Helios* meaning Sun-God, the new element was named ‘helium’. Finally, in the year 1895 Sir William Ramsey (1852-1916) was successful in isolating helium in laboratory on Earth. Then it was realised that the above mentioned yellow lines were due to presence of helium in the Sun. In this way helium was discovered in space before it was identified on Earth and an important blank space in the Periodic Table was filled up.

Four years before observations of Janssen and Lockyer, in 1864, Sir William Huggins (1824-1910) observed two bright green lines in the spectrum of Orion Nebula (which is known as the ‘sword’ of the hunter) and many other nebulae which did not match with the spectrum of any known element on Earth. Then, keeping similarity with the term ‘nebula’, Huggins named the possible new element as ‘nebulium’. Then in the year 1869, some other astronomers independently noticed a bright green line in the spectrum of the solar corona. By matching with the word ‘corona’, the possible new element was named ‘coronium’. Since corona is the outermost region of the Sun, scientists concluded that coronium must be lighter than hydrogen. But, there was no place for any element lighter than hydrogen in the Periodic Table and as such, like nebulium, coronium also remained a puzzle to scientists for many years.

Finally, in 1927, I.S. Bowen (1898-1973) solved both nebulium and coronium mystery. It was found that if normal oxygen atom becomes doubly ionised by losing two electrons from its outermost shell, then the

spectrum of that ionised oxygen shows two bright green lines as observed by Huggins. So, nebularium was no new element; it was doubly ionised oxygen. Similarly, coronium was normal iron which had lost 13 electrons; in other words, coronium was iron in an ionised state. Since the temperature of the solar corona is very high, so many electrons are removed from outer shells of an atom. But, it is not possible to create such temperatures in the conditions prevailing on Earth and hence we do not observe lines like nebularium and coronium in laboratories. For this reason, these types of lines are known as 'forbidden lines'.

The element promethium (atomic number 61) is not found on Earth. Scientists have gained knowledge about this element using particle accelerators and through some chemical reaction. But promethium has been detected in the spectrum of some stars in the Andromeda galaxy. Although Czech chemist Bohuslav Brauner (1855-1935) predicted (in 1902) the existence of this element between neodymium (atomic number 60) and samarium (atomic number 62) in the Periodic Table, its existence was not confirmed until 1945.

It was believed at a time that the interstellar space was empty. But, after the discovery of radio telescope, astronomers detected the presence of large amounts of molecular hydrogen in that region. Starting from that time, about 140 types of chemicals (including radicals and ions) have been identified in space up to the present time. Among them molecular hydrogen, carbon monoxide, formaldehyde, methanol, ethanol, di-methyl ether, formic acid, benzene, water, ammonia, hydrogen sulphide, CH^+ , HCO^+ , H_3O^+ , H_3^+ , OH^+ , CHC_nH ($n = 2$ to 8), cyanopolyacetylene type carbon chain HC_{2n+1}N ($n = 1$ to 5), etc. are present in large quantities. Fullerene, a crystalline allotrope of carbon discovered in 1985 and prepared in laboratory in 1990, is also found in space.

Primordial nucleosynthesis

According to the Big Bang theory, Universe was created about 14 billion years ago through a huge explosion. In the language of physics, that huge explosion is called the Big Bang. According to cosmological idea, within a few minutes after the Big Bang, three light elements hydrogen, helium, and lithium were produced and elements heavier

than lithium were produced within the stars through nuclear processes. One of the observational evidence in favour of the Big Bang theory is primordial nucleosynthesis; i.e., the production of the three light elements mentioned above.

The most prevalent scientific theory during 1950s for explaining the light elements production in the early Universe is credited to four scientists – Geoffrey Burbidge (1925-2010), his wife Margaret Burbidge (born 1919), William Fowler (1911-1995), and Fred Hoyle (1915-2001). This theory became famous as BBFH theory. According to this theory, all elements were produced either within the stars or through supernova explosion. On the basis of BBFH theory, it was calculated that if nuclear processes within the stars were the only source of production of all elements, then the Universe should contain about 4% helium. But, observational evidence showed that the Universe contains at least 25% helium. Similarly, complexity was seen for the presence of deuterium also because its creation was not possible within the stars. In fact, deuterium is destroyed within the stars. So, BBFH theory failed to explain the presence of observed amounts of helium and deuterium in the Universe.

On the other hand, George Gamow (1904-1968) and his collaborators were successful in explaining the primordial nucleosynthesis of light elements. According to their theory, immediately after the Big Bang, the temperature was too high for the production of any element. About three minutes after the Big Bang, the temperature dropped to about one billion degree Celsius. At that temperature, production of light elements was possible. Within a short period, deuterium was produced through impact of protons and neutrons. Then most of the deuterium was converted to helium and a small amount of tritium through collision with protons and neutrons. Again, a tritium and two deuterium nuclei combined to form lithium-7. According to this theory, there should be about 25% helium in the Universe. Besides helium, about 0.001% deuterium and smaller amount of lithium should be produced. Finer calculations have revealed that the amount of helium in the Universe is not less than 23% which fits very well with observational results. So, the correct prediction of Gamow's group about the helium production in the Universe

proved convincingly that the Universe underwent a hot phase in remote past. It is strong evidence in favour of hot Big Bang model of the Universe.

Discoveries from space probes

After discussing the role of astrochemistry in discoveries of elements and compounds in space and the primordial nucleosynthesis, let us turn our attention to discoveries made by space probes. Most of the molecules and atoms in space emit large amounts of radio and infrared radiation. So, it was decided to send spacecrafts for detecting these atoms and molecules because infrared light cannot penetrate the Earth's atmosphere. It is not possible to detect infrared radiation from ground-based observations. For identifying infrared radiation sources in space, the US space research organisation NASA sent the *Infrared Astronomical Satellite (IRAS)* to space on 25 January, 1983. It worked for ten months. Another space probe sent by the European Space Agency (ESA) for chemistry related investigations was named *Infrared Space Observatory (ISO)*. It worked from November 1995 to May 1998.

Later, two space probes, viz., *Spitzer Space Telescope (SST)* named after the famous scientist Lyman Spitzer (1914-1997) and *AKARI Space Telescope* were sent on 25 August 2003 and 21 February 2006 respectively. Earlier, the name of SST was *Space Infrared Telescope Facility (SIRTF)*. Among the space probes sent, *ISO* played a leading role in investigations related to astrochemistry. It is not possible to know much about the existence of water in space from ground-based observations due to presence of water vapour in the Earth's atmosphere. Scientists were aware of the fact that most of the water on Earth has come from space. But, using *ISO*, for the first time they could construct a model of the water cycle in space. According to this model, hydrogen was created after Big Bang and it is available everywhere in space. On the other hand, oxygen was formed by nuclear process in stars and was spread out in space through supernova explosions. In those regions of space where stars are formed, a large amount of water is formed due to proximity of hydrogen and oxygen. For instance, the Orion Nebula is a prominent star-forming region where many new stars are taking birth. In 1997, *ISO* detected a large amount of water in the Orion Nebula which, according

to calculations of astronomers, can fill up all the oceans of the Earth sixty times. That water in space is believed to have gradually moved over to other regions of space and subsequently took shelter within comets, planets and other celestial bodies.

In interstellar regions, complex carbon molecules have been found in which the number of carbon atoms exceeds one hundred. Scientists think that the structures of these molecules are similar to those of aromatic compounds. Astronomers have named these carbon compounds 'polycyclic aromatic hydrocarbons' or in short, PAHs.

It is interesting to note that the most abundant substance in space is dust. Practically all planets, comets, etc., are made of dust particles which are smaller than one thousandth of a millimetre. These dust particles have been detected by astronomers associated with *ISO*. It has been discovered in 1998 through *ISO* that the main constituents of dust particles is crystalline silicates like olivine. Previously it was believed that silicate type dust particles are amorphous. But, if

they are crystalline then the existence and path of every dust particle can be monitored. Till now this type of crystalline silicate has been detected in comets (for example, Hale-Bop), planet forming gaseous discs, etc.

Dust particles play vital role in space. Usually after collision of free atoms, they tend to recede from each other before chemical bonding are formed. But, atoms staying on dust particles can remain there till chemical bonding and chemical reaction take place. It is thought that molecular hydrogen has been formed in space through this process. Perhaps, simple compounds like water, methane and ammonia have also been produced in the same way. Dust particles have also some role in shielding molecules from the destructive stellar radiation.

ISO has discovered a new radical in space. It is methyl (CH_3) radical. Nobel Laureate scientist Gerhard Herzberg (1904-1999) predicted the existence of this radical in space. Due to hyper-reactivity, methyl radical is called a 'free radical'. Since its life-time is only one millionth of a second,

it is very difficult to detect this radical on Earth. A team of Spanish astronomers has also identified benzene for the first time in interstellar space. This benzene has been found around the planet-forming star CRL 618. According to the discoverers, benzene is produced at a particular stage of stellar evolution. Presence of benzene is essential for formation of more complex organic molecules.

Conclusion

In the preceding sections, some important discoveries related to astrochemistry have been discussed very briefly. In this International Year of Chemistry we try to trace back the path of evolution of chemistry and simultaneously pay our homage to those celebrities whose significant contributions have enriched the subject as well as the entire civilization. In this way we realise that advancement of knowledge is a continuous process and human being is the sole creator of this progress and no supernatural entity is responsible for it. ■



Vigyan Prasar
and
DECU/ISRO



Jointly Presents
New Science Video Serial

'Nano Ki Duniya'

Every Tuesday on DD National at
08.30-09.00 AM. from 02 August, 2011

The 13 Episode series on wonders of Nanotechnology. The magic of Nanotechnology is mind boggling. Until the advent of nanotechnology detecting RDX was a near impossibility. One had to do physical check or use sniffer dogs. Both are unreliable. RDX is a very stable chemical compound and hence it is near non volatile. Even when kept in open one would find only parts per million molecules of RDX in air around it. However nanotechnology based detection devices could be made that could change the security scenario completely.

A weekly News and Current Affairs
Programme on S&T



Vigyan Prasar
and
Lok Sabha TV



Jointly Presents
Weekly Science News Programme

'Science this Week'

(In English)

'Vigyan Darpan'

(In Hindi)

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

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

A lady behind the science & environment awareness in Punjab – Dr. Neelima Jerath

Executive Director of Punjab State Council for Science & Technology, Chandigarh and Member Secretary, Punjab Biodiversity Board Dr Neelima Jerath is a well known activist in the area of science and environment education and awareness. A learner of environment education and leadership from International Centre for Conservation Education, UK and Smithsonian Institution, USA, Dr Jerath has specialisation in ecology and environmental science with double gold medals. Recipient of several awards for environmental awareness Dr Jerath has worked as Asia Nodal Officer for UNESCO's project on 'Integrating Environment Policy, Education in Technical & Vocational Education'. Dr Jerath has authored/edited 16 books and several research papers, popular articles and developed resource material like educational kit, posters, booklets and reports on environment education and training, biodiversity conservation, and IPR issues.

Under the dynamic leadership of Dr Neelima Jerath a team of scientists and science communicators of Punjab State Council for Science & Technology are working for the various projects of science, technology and environment which include popularisation of science, conservation of environment, consultancy to industries for enduring development, biotechnological interventions and patent information. Dr Jerath and her team are quite impatient to resolve the problems peculiar to Punjab such as, water logging, chemically oversaturated soils and their deteriorating fertility, stagnating agricultural productivity, ground water depletion and its pollution, selenium toxicity, conservation of eco-systems, etc.

Recently Er Anuj Sinha, Director, Vigyan Prasar and Consultant, Department of Science & Technology, Govt. of India interacted with Dr Neelima Jerath on the activities to promote scientific temper, environmental awareness, conditions of science and technology research and popularisation in Punjab. Here are excerpts of the conversation.

Er Anuj Sinha : Dr Jerath, on

behalf of our readers, I am delighted that you have agreed to be on the hot seat for this issue of DREAM 2047. Can you tell us about your academic career, please?

Dr Neelima Jerath : I did my Masters in Botany with specialisation in forest ecology from Deen Dayal Upadhyay University, Gorakhpur. This was one of the key departments pursuing ecological studies in the seventies. I incidentally not only topped in my subject but was the University



Dr Neelima Jerath an activist involved in S&T awareness and reduction of carbon foot-prints in Punjab

woman topper amongst all subjects and was awarded a special gold medal for this feat. For my research I chose to work on environmental issues. My thesis was on 'Eco-physiological responses of certain plant species to urea fertiliser factory effluents'. Subsequently, I got a chance to pursue a certificate course on environment education at International Centre for Conservation Education at Cheltenham, U.K. and on Environment Leadership at Smithsonian Institution, U.S.A. During this period I also pursued a Diploma in Management from IGNOU.

AS : This is really impressive. Belated but do accept my felicitation on your academic achievements. What were the reasons for your course choices and how do you see it in retrospect?

NJ: Frankly, for my Masters I was proposing to take up chemistry. However, one of my very illustrious professors, who

had worked on morphogenesis with Dr. Katherins Esau in the US, motivated me to join botany. Choosing forest ecology was a difficult decision for a young girl at that time, primarily because it required staying in the forest during field visits. However, I was deeply influenced by the Stockholm Conference of 1972 and was an active member of International Youth Federation and a Founder Member of Gorakhpur Environment Action Group. This motivated me to work in the area of ecology and environment. I got full support from my parents and family for this decision. I was the only girl candidate amongst 15 boys.

AS : The leadership potential was present in you at a very early stage in your life. Did your initial years in Fertiliser Nagar, Gorakhpur have a major influence? You know who my mentor in the industry was.

NJ : Yes Sir. The period is etched very deeply in my psyche. Your time and energy was devoted to the production of fertiliser but we lived in a very open environment in the township of the industrial unit where girls got equal opportunities, if not more. The fertiliser sector, being a sunrise sector at that time, saw several international exchange visits. This provided us an international exposure and an up-class environment to develop and pursue our dreams.

AS : What would you count as your major accomplishments while working as a scientist in the Punjab S&T Council for several years?

NJ : I must take this opportunity to thank my mentors for giving me an environment which helped me provide the Council an international perspective through my projects with UNESCO, UNDP, NASA, etc. It was a proud moment when UNESCO itself contacted us for the first time to lead a multi-country project on Integrating Environment Education in Technical and Vocational Education in Asia. The penetration of IPRs in educational and SSI Sector in Punjab can be taken as another important achievement. I also lead a major biodiversity study in the Shivaliks

of Punjab where we worked together with three national and one state institution involving more than 50 scientists. I also acknowledge the contribution of Dr N. S. Tiwana, my predecessor, in conceptualising and promoting the Knowledge City concept. The Biotech Park is now under the process of being established, based on the vision of Dr Tiwana.

AS : You just mentioned your involvement in UNESCO projects on environmental awareness. What were the important lessons for science communicators from this?

NJ : The Council has been involved in several UNESCO projects on environment awareness. One of the recent projects was on 'Capacity Building for Biodiversity-based Livelihoods in the State'. You, Sir were involved in reviewing the posters and other material and are aware of the challenges that we faced. We did not compromise on the quality or the content and struggled at every stage.

Important lessons were learnt on the need for valuing local/traditional knowledge, overcoming outsider effect, respecting people's rights and beliefs and empowering local communities for effective resource management.

AS : I hope this will be internalised by our science communicators. Dr Jerath, you spoke about the initiatives for encouraging biotechnology. How can this field of biotechnology have a greater impact in the development of Punjab?

NJ : Biotechnology is being promoted in a big way in Punjab. We have identified an internationally renowned developer and expect a biotech industry revolution in Punjab with foreign investment. This will have a major impact on knowledge driven economy and employment. We also expect local entrepreneurship development in this highly investment intensive area as we are offering several common facilities at a reasonable cost in the Park. Further, we are trying to forge international collaborations for research and development and one such exploratory exercise has already been initiated with the Royal Society of Scotland. Since,

the Park is the first agri-food biotechnology cluster, the Council hopes that agri-food processing will receive a major boost in the State.

AS : This is very promising but where does Punjab stand vis-a-vis Science and Research Indexes as compared to other large states and how do you plan to improve the ranking?

NJ : As per a survey by National Council of Applied Economic Research carried out in 2004-05, S&T index of Punjab falls within the range 0.4 to 0.7 with states like Delhi, Tamil Nadu, Kerala, Andhra Pradesh, etc. It is ahead of states like Gujarat, Maharashtra and Karnataka comparable to it in size and population. With the initiation of several State and Central programmes to promote science and technology and the establishment of the Science City, this index would have changed for the better lately with more awareness and dissemination of



Dr Neelima Jerath in her chamber interacting with Er Anuj Sinha, Director, Vigyan Prasar

knowledge amongst masses. However, high-end R&D infrastructure in Punjab is less as compared to many other states. Taking into account the entrepreneurial spirit of the Punjabis, more S&T infrastructure needs to be developed and extra-mural research needs to be promoted. A little after your term of service on the Advisory Council, we have taken vigorous steps in this direction.

AS : Your term as Executive Director has witnessed setting up of Indian Institute of Science Education and Research in Mohali and other institutions for promoting biotechnology, etc. Are these functioning the way you envisaged?

NJ : Most of the institutions in the Knowledge City are, by and large, working as per schedule. IISER has established its own campus, NABI has developed high-end research facilities in its transit campus and has involved national and international institutions in its R&D activities, and PBTI has set up state-of-art laboratories which are duly accredited by National Accreditation Board for Laboratories. The bio-processing unit and INST need to pick up. For the biotech park a developer has already been identified and a Section 25 Company has been incorporated which will function from within the PSCST.

AS : What are your priorities for the Council as it prepares to enter the 12th Five Year Plan period? Is the government responsive to these priorities?

NJ : We would like to strengthen Centre-State partnership for technology transfer and promote the Research-Industry Partnership Model proposed by the Central Govt. where the Council could act as a facilitator as well as a service provider. We would like to establish CDM and energy audit facilities for use by State Govt. Departments and industry at 'no profit no loss' basis. I also look forward to establishing at least one 'Centre of Excellence' for research in biomass utilization, as Punjab has a large unutilised agri-biomass resource.

AS : What are the major societal issues in the state and do you perceive some significant role for science communication in addressing these?

NJ : Gender bias, women empowerment, health and nutrition, water quality and availability, pesticide pollution, etc., are some of the important societal issues which need to be addressed through science communication. Since Punjab is a progressive State with well developed infrastructure, use of GIS and RS for navigation and natural resource management needs to be promoted. Another important area for S&T communication is resource and energy efficiency improvement and pollution control technologies in the small scale sector.

AS: If we had a scale to measure Scientific Temper, (1 to 100 with 100 being the ideal), where would you place the average rural citizen vis-a-vis the typical urban Punjabi and why?

NJ: This is a question that does not have a clear reply. I would say that scientific temper in rural areas in Punjab is quite high and almost comparable to that in urban areas. One of the primary reasons is that the rural population comprising of farmers, is inherently progressive in nature and accepts S&T inputs whenever guided appropriately. The PAU through KVKs takes up effective extension work. The State Govt. has also adopted several steps/policies pro actively to ensure that the benefits of S&T percolate to the masses. Another important contributory factor is the improvement in technical education through establishment of a large number of technical institutions, especially through Punjab Technical University. Further, the percentage of NRIs from rural Punjab (especially from the Doaba belt) is quite high. Hence, the intervention of computers and Internet as a cheap means of communication is highly discernible.

AS: Besides reports and proposals, what have you been reading recently?

NJ: I was recently reading *The Borrowed Earth* by R.E. Hernan which brings out lessons from fifteen worst environmental disasters of the World. I am also fond of poetry and non-fiction. One of the recent books which I read was *The Monk who Sold His Ferrari* by Robin Sharma.

AS: This is reflection of your tastes in reading. Any personal goals for the next twelve months that you would like to share?

NJ: We are presently working on a proposal for Technology Accreditation and Validation Centre, including a Centre for Green Technologies for Punjab. Though it is expected to take a longer time to see the light of the day, within the next twelve months we would try to convince the government on the need of such a Centre and acceptance in principle for preparing a full-scale proposal. I also look forward to taking up an exercise for assessment of socio-economic impact of technology facilitation and S&T activities in the State. We would like to build confidence in the industry on our capabilities for taking up industry specific R&D works to improve R&D penetration in MSME.

AS: Thank you. It has been a pleasure talking to you. ■

of dyes have either hydroxyl groups or amino groups attached to the basic structural unit of anthraquinone.

Acridine dyes: The chromophore of acridine dyes is also a quinoid ring. These dyes are derived from acridine and they are consistently basic. Taking advantage of their fluorescent characteristics they are used for specialised purposes.

Arylmethane dyes: These dyes are called arylmethane dyes because they are derived from methane (CH_4) by replacing its hydrogen atom with aryl rings.

Azo dyes: These dyes are based on $-\text{N}=\text{N}-$ azo structure.

Indophenol dyes: These dyes are derivatives of indophenols.

Nitro dyes: The chromophore for these dyes is a nitro group ($-\text{NO}_2$). Picric acid is the most common example of nitro dyes.

Phthalocyanine dyes: The derivatives of phthalocyanine are called phthalocyanine dyes.

Nitroso dyes: The nitroso ($-\text{N}=\text{O}$) functional group in these dyes acts as chromophore.

Thiazine dyes: The derivatives of thiazine are called thiazine dyes.

Thiazole dyes: These dyes are derivatives of thiazole

Pigments

Naturally occurring mineral pigments have been used as colourants since pre-historic times. Some of the metallic pigments are: yellow ochre, sienna and umber (oxides of iron); litharge and red lead (oxides of lead); lead chromate or chrome yellow (an important yellow pigment) and white lead, or basic lead; ultramarine; and Prussian blue (ferric ferrocyanide). Organic compounds are also used as pigments. Most black pigments are organic.

Pigments are present in plants and animals. The pigments chlorophyll, xanthophylls and anthocyanin occur in plants. Chlorophyll and xanthophylls are also found in some animals. The pigment haemoglobin is responsible for the red colour of the blood. Colouration of human skin is caused by the presence of pigments.

Pigments are used for colouring paint, ink, plastic, fabric, cosmetics, food and other materials. Permanence and stability are

desirable properties for making a pigment useful. Those pigments which are not stable are called fugitive pigments, which fade over time or with long exposure to light.

Most pigments are charge-transfer complexes like transition metal complexes with broad absorption bands that subtract most of the colours of the incident light.

Creating a desired colourant is a real challenge

Creating a new dye for use is a challenging task. The first step is the synthesis of a new molecule providing the desired colour – creating a molecule with the desired colour but resistant to fading on being exposed to sunlight or by frequent washing. The next problem one faces is that of fixing the dye permanently to the fabric. One dye cannot be suitable for every kind of fabric. There are basically two ways by which a dye can be made permanently stuck to the fabric — the diffusion method and the affinity method. The diffusion method traps dye molecules between the strands of the fibre and the affinity method relies on the attraction between the fibres and the dye molecules. Ideally the new dye should be biodegradable.

References

1. Matthews, Philip, *Advanced Chemistry* (Low Priced Editions), Cambridge: Cambridge University Press, 1996.
2. Heilbron, J. L. (Ed.), *The Oxford Companion to the History of Modern Science*, Oxford: Oxford University Press, 2003.
3. Finar, I. L., *Organic Chemistry*, Vol. I: The Fundamental Principles (Third Edition), London: Longmans, Green and Co, 1959.
4. Available sources on the Internet

(The article is a popular presentation of the major aspects of dyes and pigments available in the existing literature. The idea is to inspire the younger generation to know more about these interesting chemicals. The author has given the sources consulted for writing the article. However, the sources on the Internet are numerous and have not been individually listed. The author is grateful to all those whose works have contributed to writing this article and the sources of the pictures reproduced here.) ■

The Spectrum of Autism

All You Want to Know About



Dr Yatish Agarwal
e-mail: dryatish@yahoo.com

“You may give them your love but not your thoughts.
For they have their own thoughts.
You may house their bodies but not their souls,
For their souls dwell in the house of tomorrow, which you cannot visit, not even in your dreams.”
—Kahlil Gibran in *The Prophet*, “On Children”

Autism is a group of serious developmental problems. Called autism spectrum disorders, they appear in early childhood — usually before age three, and produce a wide variety of symptoms. In general, there is a failure to develop language and communication skills, inability to form social relationships, and a marked need to follow routines. These disorders are more common in boys.



At least 2 in 3 autistic children have generalised learning disabilities. Rarely, however, some affected children may have normal or above-average intelligence.

Autism spectrum disorders are possibly caused by abnormalities of the brain. The disorder sometimes runs in the families, which suggests that genetic factors may be involved.

About 10 per cent autistic children have a genetic abnormality, such as fragile X-syndrome.

The rising numbers

The number of children diagnosed with autism appears to be rising. It is not clear whether this is due to better detection and reporting of autism, a real increase in the number of cases, or both.

While there is no cure for autism, intensive, early treatment can make a big difference in the lives of many children with the disorder.

Recognising autism

Children with autism generally have problems in three crucial areas of development — social interaction, language, and behaviour. But because autism symptoms vary greatly, two children with the same diagnosis may act quite differently and have strikingly different skills. In most cases, though, severe autism is marked by a complete inability to communicate or interact with other people.

Some children show signs of autism from birth, such as arching the back to avoid physical contact. In infancy, a child with autism may bang his or her head against the side of the cot. Other children may appear normal for the first few months or years of life but then suddenly become withdrawn, become aggressive or lose language skills that they have already acquired.

Though each child with autism is likely to have a unique pattern of behaviour, some autism symptoms are common:

Social skills

- Fails to respond to his or her name
- Has poor eye contact
- Appears not to hear you at times
- Resists cuddling and holding
- Appears unaware of others' feelings
- Seems to prefer playing alone — retreats into his or her “own world”

Language skills

- Starts talking later than age two, and has other developmental delays by 30 months
- Loses previously acquired ability to say words or sentences
- Doesn't make eye contact when making requests
- Speaks with an abnormal tone or rhythm — may use a singsong voice or robot-like speech
- Can't start a conversation or keep one going
- May repeat words or phrases verbatim, but doesn't understand how to use them

Behaviour

- Performs repetitive movements, such as rocking, spinning or hand-flapping.
- Develops specific routines or rituals.
- Becomes disturbed at the slightest change in routines or rituals.
- Moves constantly.
- May be fascinated by parts of an object, such as the spinning wheels of a toy car.
- May be unusually sensitive to light, sound and touch and yet oblivious to pain.
- Young children with autism also have a hard time sharing experiences with others. When read to, for example, they are unlikely to point at pictures in the book. This early-developing social skill is crucial to later language and social development.
- As they mature, some children with autism become more



engaged with others and show less marked disturbances in behaviour. Some, usually those with the least severe problems, eventually may lead normal or near-normal lives. Others, however, continue to have difficulty with language or social skills, and the adolescent years can mean a worsening of behavioural problems.

Intelligence

Most children with autism are slow to gain new knowledge or skills, and some have signs of lower than normal intelligence. Other children with autism have normal to high intelligence. These children learn quickly yet have trouble communicating, applying what they know in everyday life and adjusting in social situations. A small number of children with autism are “autistic savants” and have exceptional skills in a specific area, such as art, math or music.

When to see a doctor

Babies develop at their own pace, and many don't follow exact timelines found in doctors' charts and parenting books. Most children with autism, however, usually show some signs of delayed development by 18 months. If you suspect that your child may have autism, discuss your concerns with your doctor. The earlier the treatment begins, the greater is the possibility of it being useful.

When to go for developmental tests

A doctor may recommend developmental tests if your child:

- Doesn't babble or coo by 12 months

- Doesn't gesture — such as point or wave — by 12 months
- Doesn't say single words by 16 months
- Doesn't say two-word phrases by 24 months
- Loses previously acquired language or social skills at any age

Causes

Autism has no single, known cause. Given the complexity of the disease, the range of autistic disorders and the fact that no two children with autism are alike, many causes are likely. These may include:

Genetic links

A number of genes appear to be involved in autism. Some may make a child more susceptible to the disorder; others affect brain development or the way brain cells communicate. Still others may determine the severity of symptoms. Each problem in genes may account for a small number of cases, but taken together, the influence of genes may be substantial. Some genetic problems seem to be inherited, whereas others happen spontaneously.

Environmental factors

Many health problems are due to both genetic and environmental factors, and this is likely the case with autism as well. Researchers are currently exploring whether viral infections and air pollutants, for example, play a role in triggering autism.

No link between vaccines and autism

One of the greatest controversies in autism is centred on whether a link exists between autism and certain childhood vaccines, particularly the measles-mumps-rubella (MMR) vaccine. No reliable study has shown a link between autism and the MMR vaccination. A study published in late 1990s that theorised there could be a link has been retracted because there's little evidence to support that theory.

Avoiding childhood vaccinations can place your child in danger of catching serious diseases, including whooping cough, measles or mumps.

Risk factors

Autism affects children of all races and nationalities, but certain factors increase a child's risk. They include:

Your child's sex. Boys are three to four times more likely to develop autism than girls.

Family history. Families who have one child with autism have an increased risk of having another child with the disorder. It is also

not uncommon for the parents or relatives of an autistic child to have minor problems with social or communication skills themselves or to engage in certain autistic behaviours.

Other disorders. Children with certain medical conditions have a higher than normal risk of having autism. These conditions include fragile X syndrome, an inherited disorder that causes intellectual problems; tuberous sclerosis, a condition in which benign tumours develop in the brain; and the neurological disorder Tourette syndrome.



Parental age. Having an older father (being 40 or older) may increase a child's risk of autism. There may also be a connection between children being born to older mothers and autism, but more research is necessary.

Seeing the doctor

Your child's doctor will look for developmental problems at regular checkups. If he or she shows any autism symptoms, your child will likely be referred to a paediatric neurologist or developmental paediatrician for a thorough clinical evaluation.

What you can do

It's a good idea to be well prepared for your child's appointment. Write down all the changes that you and others have observed in your child's behaviour. The specialist will examine your child carefully and monitor growth and development, but your daily observations are also extremely important.

- Make a list of any medications, including vitamins, herbs and over-the-counter medicines that your child is taking.
- If possible, bring a family member or friend with you. This is important not just to help you remember information but also for emotional support.
- If you have a baby book record of developmental milestones for your child, bring that record.
- If your child has unusual behaviours or movements recorded on a video, bring the video.
- If your child has siblings, try to remember when his or her siblings began talking and reached other developmental milestones, and share that information with your child's doctor.
- Tell your child's doctor about any observations from other adults and caregivers, such as teachers.

What to ask of your child's doctor

Write down questions that you want to ask your child's doctor. Don't be afraid to ask questions or to speak up when you don't understand something that's said.

You might think about asking the following questions:

- Why do you think my child has autism?
- Is there a way to confirm the diagnosis?
- If my child has autism, is there a way to tell how severe it is?
- What changes can I expect to see in my child over time?
- Can I take care of my child at home, or will I need to look for outside care?
- What kind of special therapies do children with autism need?
- How much and what kinds of regular medical care will my child need?
- What kind of support is available to families of children with autism?
- How can I learn more about autism?

What to expect from your child's doctor

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

- What specific behaviours prompted your visit today?

- When did you first notice these symptoms in your child?
- Have these behaviours been continuous or occasional?
- Does your child have a family history of autism, language delay, Rett's syndrome, obsessive-compulsive disorder, anxiety or other mood disorders?
- Does your child have any other symptoms that might seem unrelated to autism, such as gastrointestinal problems?
- Does anything seem to improve your child's symptoms?
- What, if anything, appears to worsen your child's symptoms?
- When did your child first crawl? Walk? Say his or her first word?
- What are some of your child's favourite activities? Is there one that he or she favours?
- Have you noticed a change in his or her level of frustration in social settings?

Tests and Diagnosis

Your child's doctor will look for signs of developmental delays at regular checkups. If your child shows some signs of autism, you may be referred to a specialist in treating children with autism. This specialist, working with a team of professionals, can perform a formal evaluation for the disorder. However, such specialists and specialist teams are only available in tertiary care hospitals in the metro cities of India.

Since autism varies widely in severity, making a diagnosis may be difficult. There is no specific medical test to pinpoint the disorder. Instead, an autism specialist will observe your child and talk to you about how your child's social skills, language skills and behaviour have developed and changed over time. To help reach a diagnosis, your child may undergo a number of developmental tests covering speech, language and psychological issues.

Although the signs of autism often appear by 18 months, the diagnosis sometimes isn't made until age 2 or 3, when there may be more obvious delays in language development and social interactions. Early diagnosis is important because early intervention — preferably before age 3 — appears to be the most helpful.

Diagnostic criteria for autism

For your child to be diagnosed with autism, he or she must meet the symptom criteria spelled out in the *Diagnostic and Statistical Manual of Mental Disorders* (DSM). This manual is published by the American Psychiatric Association and is used by physicians to diagnose mental conditions for treatment.

To be diagnosed with autism, your child must have six or more of the following symptoms and two or more of those symptoms must fall under the social skills category.

Social skills

- Has difficulty with nonverbal behaviours, such as making eye contact, making facial expressions or using gestures
- Has difficulty forming friendships with peers and seems to prefer playing alone
- Doesn't share experiences or emotions with other people, such as sharing achievements or pointing out objects or other interests
- Appears unaware of others' feelings

Communication skills

- Starts talking later than age 2 and has other developmental delays by 30 months, and doesn't make an attempt to communicate with gestures or miming.
- Can't start a conversation or keep one going.
- May repeat words or phrases verbatim, but doesn't understand how to use them.
- Doesn't play make-believe or doesn't imitate the behaviour of adults when playing.

Behaviour

- Develops interests in objects or topics that are abnormal in intensity or focus.
- Performs repetitive movements, such as rocking, spinning or hand-flapping.
- Becomes disturbed at the slightest change in routines or rituals.
- May be fascinated by parts of an object, such as the spinning wheels of a toy car.

Treatment

There is no cure for autism, and there is no "one-size-fits-all" treatment. Treatment normally focusses on education designed to maximise a child's potential. Language and speech therapy can help improve communication skills. Behaviour therapy can help to replace abnormal behaviour with more appropriate ones, and occupational therapy can improve physical skills. A highly structured daily routine is usually recommended.

Behaviour and communication therapies

Many programmes have been developed to address the range of social, language and behavioural difficulties associated with autism. Some programs focus on reducing problem behaviours and teaching new skills. Other programs focus on teaching children how to act in social situations or how to communicate better with other people. Though children don't always outgrow autism, they may learn to function well with the disorder.

Educational therapies

Children with autism often respond well to highly structured education programs. Successful programs often include a team of specialists and a variety of activities to improve social skills, communication and behaviour. Preschool children who receive intensive, individualised behavioural interventions show good progress.

Medications

No medication can improve the core signs of autism, but certain medications can help control symptoms. Antidepressants may be prescribed for anxiety, for example, and antipsychotic drugs are sometimes used to treat severe behavioural problems.

Managing other medical conditions

Autistic children may also have other medical conditions, such as epilepsy or gastrointestinal problems. Talk to your child's doctor about how to best manage your child's conditions together, and always tell each of your child's doctors all the medications and

supplements your child is taking. Some medications and supplements can interact, causing dangerous side effects.

Coping and Support

Raising a child with autism can be physically exhausting and emotionally draining. These ideas may help:

Find a team of trusted professionals

You'll need to make important decisions about your child's education and treatment. Find a team of teachers and therapists who can help look at the options in your area and explain the resources for children with disabilities.

Take time for yourself and other family members

Caring for a child with autism can be a round-the-clock job that puts stress on your marriage and your whole family. To avoid burnout, take time out to relax, exercise or enjoy your favourite activities. Try to schedule one-on-one time with your other children and do not give up on your marital life. You could plan to spend time with your spouse — even if it's just watching a movie together after the children go to bed.

Seek out other families of autistic children

Other families struggling with the challenges of autism can be a source of useful advice. Many communities have support groups for parents and siblings of children with autism.

Learn about the disorder

There are many myths and misconceptions about autism. Learning the truth can help you better understand your child and his or her attempts to communicate. With time, you'll likely be rewarded by seeing your child grow and learn and even show affection — in his or her own way.

Most children with autism spectrum disorders cannot lead independent lives and require long-term care from their parents. If you've been handed such a major responsibility, it is best that you should plan ahead. Guilt, remorse and high-handed behaviour with the child cannot do any good; being positive and standing up to the special needs of your child is always the best course. ■



Recent developments in science and technology

Hydrogen peroxide found in space

Hydrogen peroxide is a highly reactive and unstable compound which spontaneously decomposes into water and oxygen. It is a strong oxidising agent and is used as a disinfectant, antiseptic, and in rocketry as a



The colourful Rho Ophiuchi star formation region, about 400 light-years from Earth, contains very cold, dense clouds of cosmic gas and dust. Astronomers using the APEX telescope to observe this region discovered hydrogen peroxide molecules in interstellar space for the first time, in the area marked with the red circle. (Credit: ESO)

propellant. Hydrogen peroxide is naturally produced in living organisms as a by-product of oxidative metabolism. Nearly all living organisms that are exposed to oxygen possess enzymes known as catalases which harmlessly and catalytically decompose low concentrations of hydrogen peroxide to water and oxygen. Recently, molecules of hydrogen peroxide have been discovered for the first time in interstellar space. An international team of astronomers made the discovery with the Atacama Pathfinder Experiment (APEX) telescope, situated on the 5,000-metre-high Chajnantor plateau in the Chilean Andes. They observed a region in our galaxy close to the star Rho Ophiuchi, about 400 light-years away (*Astronomy & Astrophysics*, July 2011, DOI: 10.1051/0004-6361/201117170).

The region where hydrogen peroxide was found contains very cold (around minus

250 degrees Celsius), dense clouds of cosmic gas and dust, in which new stars are being born. The clouds are mostly made of hydrogen, but contain traces of other chemicals, and are prime targets for astronomers hunting for molecules in space. Telescopes such as APEX, which make observations of electromagnetic radiation at millimetre- and submillimetre-wavelengths, are ideal for detecting the signals from these molecules. According to Per Bergman, astronomer at Onsala Space Observatory in Sweden and lead author of the study, “the amount of hydrogen peroxide in the cloud is just one molecule for every ten billion hydrogen molecules, so the detection required very careful observations.”

But how does a reactive molecule like hydrogen peroxide form in space? The researchers believe that hydrogen peroxide is formed on the surfaces of cosmic dust grains – very fine particles similar to sand and soot – when hydrogen combines with oxygen molecules. A further reaction of the hydrogen peroxide with more hydrogen is one way to produce water.

The discovery gives vital clues about the chemical link between two molecules critical for life: water and oxygen. On Earth, hydrogen peroxide plays a key role in the chemistry of water and ozone in the atmosphere. Discovery of hydrogen peroxide molecule in interstellar space may provide a clue to the presence of water on Earth because much of the water on our planet



Biman Basu

e-mail: bimanbasu@gmail.com

is thought to have originally formed in space. The detection of hydrogen peroxide in space will therefore help astronomers better understand the formation of water in the universe. The discovery may also help astronomers understand another interstellar mystery: why oxygen molecules are so hard to find in space.

Source of cosmic dust found

Cosmic dust is a type of dust composed of particles in space which are a few molecules to 0.1 micrometres (1 micrometre = 1 millionth of a metre) in size. Such dust is found in space between galaxies, between stars, and even between planets. Cosmic dust is made of various elements, such as carbon, oxygen, iron and other atoms heavier than hydrogen and helium. Cosmic dust was once considered a hindrance in for astronomical observations, as it obscures objects astronomers wanted to observe. But after the advent of infrared astronomy, the dust particles were found to be significant and vital components of astrophysical processes. Cosmic dust plays a crucial role



Supernova 1987A (arrow) in the Large Magellanic Cloud shot out huge quantities of cosmic dust into space.

in the formation of planets and also stars like the Sun.

Till now the origin of cosmic dust was not known for certain, but recent findings by European Space Agency's powerful *Herschel Space Observatory* provide a definite clue about the source of cosmic dust in space. New observations made by *Herschel* in infrared wavelengths reveal that an exploding star expelled the equivalent of between 160,000 and 230,000 Earth masses of fresh dust. This enormous quantity suggests that exploding stars, called supernovae, are the answer to the long-standing puzzle of what supplied our early universe with dust. The discovery was made by a team led by Mikako Matsuura from University College London from the study of images of the remnants of a supernova called SN1987A, which was visible in the Large Magellanic Cloud 24 years ago (*Science*, 8 July 2011 DOI: 10.1126/science.1205983). The Large Magellanic Cloud is a small galaxy situated very near our Milky Way galaxy and is visible in the southern sky.

Herschel is designed to detect the longest infrared wavelengths, which means it can see very cold objects that emit very little heat, such as dust. When a star in the Large Magellanic Cloud exploded as supernova in 1987 the resulting shockwave shot out material in a disc of gas and dust around the star, which is still travelling outwards at speeds of up to 6,000 km/s. The pulse of light from the supernova lit up a ring of material almost a light year (10 million million km)

across, dozens of times the size of our solar system. This material glows in visible and ultraviolet light, as well as in x-rays. Small amounts of dust in the ring were warmed to a temperature of minus 100 degrees Celsius, and this glows faintly in infrared light. This dust is what *Herschel* has detected. According to the researchers, the dust was formed from material that was thrown away from the star in the initial explosion, and if similar amounts are created in all such explosions, this could explain the origin of much of the dust seen in the Large Magellanic Cloud and also in interstellar space.

From Earth, most of the galaxies seen in the very distant universe appear very faint in visible light, but quite bright in the far-infrared as seen by *Herschel*. This is because they contain large quantities of dust, which blocks most of the visible light from the stars in the galaxies. The recent observations by *Herschel* of SN1987A would help to explain where most of that dust comes from. For astronomers the new findings would provide valuable clues to the formation of distant galaxies 8-10 billion years ago, a period in the universe when stars were forming at rates higher than ever before or since.

Gene editing may cure haemophilia

When blood vessels are cut or damaged by injury, the loss of blood is normally prevented by solidification of the blood, a process called coagulation or clotting. But in individuals suffering from haemophilia blood



Lab mice treated by gene editing to cure haemophilia B.

flowing out of cuts or bruises does not clot. Haemophilia is a genetic bleeding disorder caused by the deficiency of substances called clotting factors necessary for the formation of blood clots. People who have haemophilia are at risk of abnormal bleeding throughout the body because they do not have enough clotting factors in their blood and often need some form of intermittent treatment to prevent severe blood loss and stop internal bleeding.

Now there is hope for haemophiliacs. By using a special technique to 'edit' genes, researchers have been able to successfully

restore nearly normal blood clotting in mice suffering with the human blood disease haemophilia B. Working with newborn mice, researchers led by Katherine High at the Children's Hospital of Philadelphia, USA, found that molecular editors called zinc finger nucleases (ZFNs) can correct a genetic mutation that leads to the blood-clotting disorder haemophilia within the body (*Nature* online 26 June 2011 doi:10.1038/nature10177).

Editing of the human gene to correct disease-causing mutations is a promising approach for the treatment of genetic disorders. Genome editing improves on simple gene-replacement strategies by effecting *in situ* correction of a defective gene, thus restoring normal gene function without the risks associated with random insertion into the genome. Zinc finger nucleases are DNA-binding protein molecules designed by researchers to recognise a particular gene

and then, working in pairs, make a cut in the DNA. The cell's repair machinery then takes over, repairing the break and the defect using a healthy copy of the gene inserted by the researchers as a template. Zinc finger nucleases had been used earlier to edit mistakes out of cells grown in the laboratory, but till the present success no one had reported success with correcting genetic errors within the body of an animal.

The treated mice showed factor IX levels as high as 6 to 7 percent of normal. According to the researchers, the level of gene

targeting achieved was sufficient to correct the prolonged clotting times in a mouse model of haemophilia B, and remained persistent. There were no signs of toxicity or changes in liver function in the mice over an eight-month period. However, the researchers do not know whether genetic errors can be corrected in adult mice or in larger animals such as dogs and humans and also the editing system does not correct the mistakes in many cells. According to them refinements to the technique must still be made before it could be used in human patients, but if the process can be optimised

it may provide a way to cure many different genetic diseases.

Stem-cell-grown windpipe transplanted

Stem cells are cells with the potential to develop into many different types of cells in the body. They serve as a repair system for the body. Doctors and scientists are excited about stem cells because they have potential in many different areas of health and medical



The world's first synthetic trachea. The pink coloration is due to stem cells that have differentiated into tracheal tissue.

research. Stem cells can also be used to make cells and tissues for therapy of many diseases, as was demonstrated recently at Karolinska University Hospital in Stockholm, Sweden, where an international team of surgeons successfully carried out the world's first transplant of a synthetic windpipe grown from stem cells.

The patient was a 36-year-old African native, who has been working for a PhD in geology in Iceland. He was diagnosed in 2008 with tracheal cancer. Despite intensive treatment with radiation and chemotherapy the tumour continued to grow and ultimately became the size of a golf ball and almost completely blocked the trachea, creating severe breathing problem for the patient. The doctors then realised that trachea replacement was the only option remaining. But no suitable donor was available immediately, so the doctors decided to make a new trachea from scratch.

The surgery was a collaborative effort of experts from three continents. Dr. Paolo Macchiarini at Karolinska University

Hospital in Stockholm, who led the surgery; Prof. Alexander Seifalian from University College London, UK, who designed and built the nanocomposite (a porous material) scaffold for the synthetic trachea; and Harvard Bioscience of Boston, USA, (a global developer, manufacturer and marketer of a broad range of specialised products), which produced a specifically designed bioreactor used to grow the trachea on the scaffold with the patient's own stem cells. The scaffold was prepared using measurements acquired through 3D scans of the patient's trachea. Like a real trachea it was a kind of flexible tube segmented with stiff rings.

After being brought to Sweden, the nanocomposite scaffold was placed in a bioreactor provided by Harvard Bioscience, along with stem cells extracted from the patient's bone marrow. Chemicals inside the bioreactor induced the stem cells to differentiate into trachea tissue and they grew into the nanocomposite mould, which was porous like a sponge. The synthetic trachea was ready to implant in just two days. During the surgery Dr. Macchiarini removed the tumour and the diseased section of the trachea and replaced it with the synthetic duplicate made from stem cells. Since the organ was built from cells taken from the patient, there was no risk of it being rejected by his immune system and the patient did not need to take any anti-rejection drug.

According to the doctors, the successful transplantation of tissue engineered synthetic organs, referred to as regenerative medicine, could open new and very promising therapeutic possibilities for the thousands of patients who suffer from tracheal cancer or other conditions that destroy, block or constrict the airway. Besides the advantage of non-rejection of the transplanted organ the new treatment also means that patients would not have to wait for suitable donor organs. In addition to treating adult patients, tissue-engineered synthetic trachea transplants could be particularly valuable for children, for whom donor tracheas are much more difficult to find. ■

Letters to the editor

A perfect combination of various scientific disciplines

I have been reading the magazine Dream 2047 for the past several years. I am very much thrilled to read the articles containing various topics. I can say that it is a perfect combination of all scientific disciplines. Every issue of this magazine starts with the biography of a great scientist who was a pioneer in a particular area of science. The medical or health related article of Dr. Yatish Agrawal also provides us very informative idea about any health related problem. The article on recent developments in science and technology is a connecting link between the ongoing projects in science with common readers. The language, presentations, diagrams, and the scientific content in each issue are the pillars of success of the magazine. I express my hearty thanks for giving me this golden opportunity to read this valuable magazine to fulfill our need of knowledge about the science.

Ratnadeep Ghadage (M.Pharmacy)
Yashwant Nagar, Vita, Dist- Sangli,
Maharashtra- 415311

An informative magazine

I am thrilled to read the articles on various topics in the science magazine Dream 2047. The language, presentation, picture depiction, explanation of contents, and the solution to problems are the key attractions of your magazine. I find detailed new information regarding usage and demerits of polymers, importance of compost manure, air pollution, and recent developments in science and technology, etc. It helps me in having informative discussions on developments in science among the teachers and my students. I express my hearty thanks for giving this golden opportunity to read your esteemed magazine.

Ramesh Kumar L
32 Puliankottai Salai
Karaikal 609 602, Puducherry.

Dream 2047 Editorials in Telugu

I would like to inform you that editorials of Dream-2047 January and February 2011 issues were utilised for write-ups published in the March and April 2011 issues of the children's Telugu popular science monthly Chekhumukhi, published by Jana Vignana Vedika, A.P.

Dr. Sammeta Govardhan
Principal,
3-13-156, Kumarpally
Hanamkonda - 506001 (A.P.)

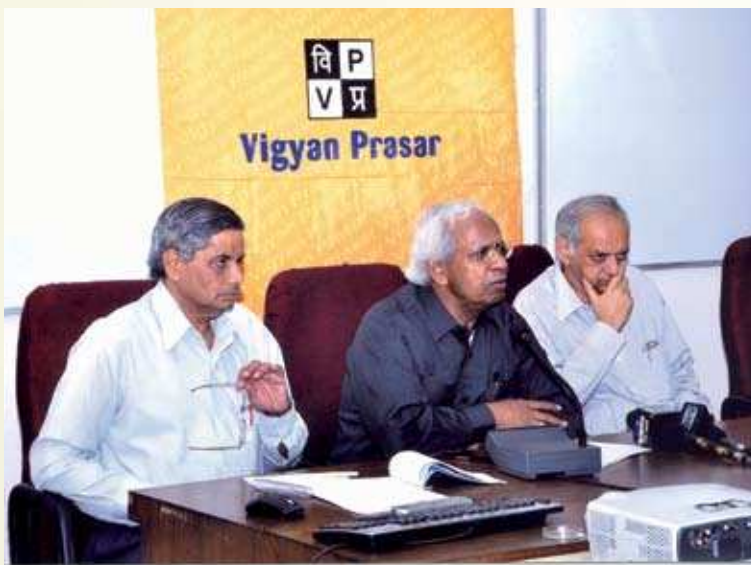
Round Table Discussion on Chemistry and Clean Technologies

Vigyan Prasar organised the first Round Table Discussion on “Chemistry and Clean Technologies” on the occasion of National Technology Day at Indian Institute of Public Administration (IIPA), New Delhi. Representatives of all national academies of engineering, medicine, agriculture and sciences participated in the discussion and identified a number of pathways for research in chemistry that could accelerate the development of clean technologies.

The leading scientists deliberated on the following issues: ‘How are scientists and engineers in research and academia contributing to the development of clean technologies?’ ‘What are the issues that need to be addressed to accelerate the process of applying developments in chemistry to clean technologies?’ ‘How can the National Academies make a higher contribution in this programme?’ ‘Can the International Year of Chemistry 2011 be remembered for significant contribution to clean technology development?’

In his welcome address Er Anuj Sinha, Director, Vigyan Prasar commented that the reduction of lead in petrol and sulphur in diesel used by the transport sector over the last two decades is strong evidence that major improvements are feasible given a mandate. Replacing ozone depleting refrigerants with eco-friendly products is another success story. Existing facilities and new processes both can benefit from inputs of chemists. Safer chemical pathways

for products with superior characteristics are necessary and form the core of clean technologies. He said that clean technologies offer a diverse range of products and services



L to R: Er Anuj Sinha, Director, Vigyan Prasar, Dr R. B. Singh, President, National Academy of Agriculture Sciences, Delhi and Prof. M. N. Gupta, Professor, IIT Delhi (representing President, The National Academy of Sciences, Allahabad) interacting with media representatives

that harness renewable materials and energy sources, dramatically reduce the use of natural resources, eliminate wastes, and reduce emissions.

Dr. R.B. Singh, President, National Academy of Agricultural Sciences, New Delhi commended the timely initiative of Vigyan Prasar in arranging the Round Table Discussion. Dr. Singh said clean or green technologies are necessary for sustained development which had been the cause of the green, blue and white revolutions in the country. He said 5 Ws and 1H of the technology determines the value and shades of the technology.

Dr. T. Karunakaran, President, Indian Academy of Social Sciences, Allahabad said chemistry has contributed to the well-being of society with better drugs, effective fertilisers, clean fuels, etc. Technologists have contributed to lowering consumption of energy and raw materials and improving efficiencies of transformations. The production of harmful wastes, hazardous processes, and the crisis of energy all signal that there are challenges for researchers, entrepreneurs, policy makers, and the common man. He proposed a new concept of Rural Economic Zone to accelerate sustainable development.

Dr. Krishan Lal, President, Indian National Science Academy, New Delhi highlighted the urgency of the issue and desired policy initiatives to address the technological challenge that would have desirable impact on mitigating the climate change effects. He used the case study of research on diamonds in NPL to highlight several facets of his talk.

Prof. M N Gupta, Professor, IIT Delhi (representing President,



Round Table Discussion in progress

About clean technologies

Clean technologies offer a diverse range of products and services that harness renewable materials and energy sources, dramatically reduce the use of natural resources, eliminate wastes, and reduce emissions. Clean technologies are competitive and superior to conventional technologies. There are significant benefits to the quality of life of people in developing countries. The group of technologies that can be retrofitted in existing processes includes selective catalysis, use of non-toxic materials, water purification, solar and wind energy, etc. The last decade has witnessed major developments in this area and industry in India – large, medium, small and rural – can benefit from these.

The National Academy of Sciences, Allahabad) said that chemistry is perceived as “Fire and sword” science, as most of the chemical reactions require harsh chemicals and harsh conditions. The amount of waste produced, number of sequential chemical steps, use of catalyst and toxicity of the product determine the “Greenness” of a process. He advocated more efforts to attract talented youth to careers in research.

Prof. A K Ganguli, Professor, IIT Delhi, who represented President, Indian Academy of Sciences, Bangalore, said chemistry is not equal to pollution, but how we work with chemicals is important. This is already proven in SMART materials with lower or zero pollution and having much better functionality. Going back to pre-historic times is not the solution to get rid of pollution. We need to work in harmony with nature to deliver the future generation from various problems.

Brig S.V.S. Chowdhry, Chairman, Safety and Quality Forum, Institute of Engineers (India) emphasised the use of clean technologies to ensure harmonious and sustainable development. He said harmful uses of technology bring out the need and importance of clean technologies.

Senior scientists from the participating organisations addressed media representatives. The declaration adopted at the Round Table Discussion proposed thrust areas for academic institutions and research laboratories. ■

Regional workshops on Science Broadcasting Lucknow, Kolkata, Pune, Thiruvananthapuram

Vigyan Prasar, in partnership with **SEVAKS**, New Delhi and host institutions invites applications for participating in a workshop on **Science Broadcasting**.

Four workshops are proposed for TV & radio professionals; amateur film makers with demonstrable interest in science communication; community radio producers; script writers; persons engaged in science communication in laboratories; voluntary organisations; faculty members of journalism schools; and professionals with experience in science video production and science communication / journalism through electronic media.

Participants under the age of 40 will be preferred. The medium of instruction will be English.

Seats are limited and the selection will be done on the basis of first come first served

Workshop will be totally residential to increase the interactions and to allow adequate time for group work. Modest accommodation and food will be provided to the participants. Travel expenses if any will have to be borne by the participants.

Registration fee: Rs. 3000/- is to be sent along with application form by crossed demand draft / multi city cheque drawn in favour of “Vigyan Prasar” payable at New Delhi.

Important dates and venues:

S. No.	Workshop Stations	Dates	Venue / Host Institutions	Last date for receipt of completed application along with fee
1.	Lucknow	5-9 September 2011	Amity University, Lucknow Campus	29th August 2011
2.	Kolkata	19-23 September 2011	University of Calcutta, Kolkata	12th September 2011
3.	Pune	14-18 November, 2011	Film and Television Institute of India (FTII), Pune	31th October 2011
4.	Thiruvananthapuram	November 2011 second fortnight*	Thiruvananthapuram*	31th October 2011

* Date & venue will be confirmed shortly.

Details of the workshop and the application form can be downloaded from Vigyan Prasar's website: <http://www.vigyanprasar.gov.in>



Vigyan Prasar

Department of Science & Technology, Govt. of India

A-50, Institutional Area, Sector - 62, NOIDA 201 309 (U.P.)

Ph.: 0120-2404430-35 Fax : 0120-240 4437

Regional Workshop on Innovative Experiments in Physics

Based on the module developed by Vigyan Prasar and IIT, Kanpur as a collaborative programme to train Master Resource persons, Vigyan Prasar has planned five regional workshops on Innovative Experiments in Physics. The fourth four day workshop was organised for the North-Eastern Zone at Shillong, during 17 May to 20 May 2011. Forty Five teachers and science communicators attended the workshop. The participants of this workshop were selected out of 200 nominations received by VP. The nominations were invited through Dream-2047, VIPNET News and Vigyan Prasar website.

The workshop was inaugurated by Shri Barkos Warjri, IAS, Addl. Chief Secretary, Govt. of Meghalaya. Other dignitaries present during the inaugural function were Shri Atul Kumar Mathur, IPS, Dr. V. B Kamble, former Director, Vigyan Prasar; Professor Manmohan Singh, NEHU and Shri R. D. West K, Member Secretary,

SCSTE, Meshalaya. Shri B K Tyagi and Shri Rintu Nath represented Vigyan Prasar.

Shri Rintu Nath and Dr. Ajay Mahajan conducted the workshop and demonstrated 120 innovative activities/experiments during the four days. Participants did hands-on activities during the workshop. Each participant assembled one kit. Using the kit about 20 activities can be performed. A CD on 'Innovative Experiments in Physics' and a kit 'Emergence of Modern Physics' developed by VP was given to all the participants. Shri B. K. Tyagi, interacted with the participants and informed how science clubs can be formed and registration can be done with Vigyan Prasar.



Demonstration of innovative experiments during the workshop

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

Vigyan Prasar Publications



Dinosaurs: Myths and Facts

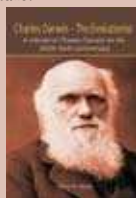
U.B. Mathur and Neera Mathur
ISBN: 978-81-7480-206-4 • Price: ₹ 120

This book answers practically all the question on the dinosaur myths and facts. The illustrated book tells a great deal about the wonderful recent finds of Indian dinosaurs skeletons, eggs, footprints, dung etc. which are some of the best in the world; and evidences in India about extinction of dinosaurs.

Charles Darwin: An Evolutionist

Parul R. Sheth
ISBN: 978-81-7480-208-8
• Price: ₹ 120

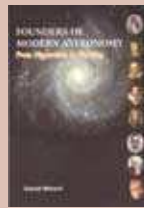
This book is a tribute to Charles Darwin's works and his ideologies and it also includes Darwin's life sketch, his love for animals and plants, his works and the debates that have arisen.



Evolution of Our Understanding of the Planetary Motions

J.N. Desai, N.M. Ashok, V.B. Kamble, S.P. Pandya
ISBN: 978-81-7480-198-2 pp : 108 • Price: ₹ 75

This book is a 'journey in time' tracing the evolution of the understanding of the motions of the planets from the very beginning. It is hoped that this book would prove useful for students and teachers in colleges and universities, along with general readers.



Founders of Modern Astronomy: From Hipparchus to Hawking

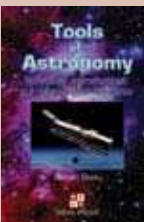
Subodh Mahanti
ISBN: 978-81-7480-200-2 • pp : 326 • Price: ₹ 200

The book presents in chronological order, the lives and works of 28 scientists who have made significant contributions to the growth of astronomy.

Heretic to Hero: Galileo Galilei-Rebel Astronomer

T V Venkateswaran
ISBN:978-81-7480-204-0 • pp : 124 • Price: ₹ 120

This book elucidates the context and the implication of Galileo's discoveries that led to what historian of sciences call as 'first scientific revolution'.



Tools of Astronomy

Biman Basu
ISBN:978-81-7480-196-8
pp : 216 • Price: ₹ 180

This book attempts to take the reader through the fascinating journey of the development and evolution of astronomical instruments through the millennia.

For further details please write to:



Director, Vigyan Prasar

A-50, Institutional Area, Sector-62, NOIDA (201307)

Phone: 91-120-240 4430,35 Fax: 91-120-2404437

e-mail : info@vigyanprasar.gov.in Website : http://www.vigyanprasar.gov.in