ISSN : 0972-169X
Registered with the Registrar of Newspapers of India: R.N. 70269/98
Postal Registration No. : DL-11360/2004

DREAM 2047

July 2004 Vol. 6 No. 10 Price: Rs. 5.00

VP News

Vigyan Rail – Science Exhibition on Wheels

Vigyan Rail arrived at Rajkot on 22nd June 2004 at 0730 hrs. The train was stationed at Bhaktinagar railway station at 0830 hrs. The exhibition was inaugurated by Dr. Vallabh Bhai Kathiria, Hon'ble MP (Lok Sabha), Rajkot, in the presence of Shri Rajiv Kumar, ADRM, and Shri Sanjay Kumar Shukla, ACM. Dr. V.B. Kamble, Director, Vigyan Prasar, was also present at the inauguration function. Reporters from many news channels and newspapers were present to cover the function. Since, there were huge crowd to see the exhibtion, timings were changed from 0700 hrs to 2130 hrs. Visitors from far flung areas like Jamnagar, Junagadh also visited the

contd on page... 24

Dr. V.B. Kamble, explaining exhibits to Dr. Vallabh Bhai Kathiria, Hon'ble MP, Rajkot

VIPNET Western Regional Workshop

Vigyan Prasar (VP) and Marathi Vidnyan Parishad (MVP), Mumbai jointly hosted a VIPNET Western Regional workshop at Marathi Vidnyan Parishad, Mumbai. Twenty five teachers/science workers from Rajasthan, Gujarat, Maharashrta and Goa attended the workshop during 18-19-20 June, 2004.

In the inaugural session Mr. D.N. Herlekar, Executive Director, Marathi Vidnyan Parishad introduced Marathi Vidyan Parishad. Dr. Subodh Mahanti introduced Vigyan Prasar and explained briefly how the working of VIPNET clubs take place in different states and VP orchestrates the network. He briefed the theme of the current workshop and its necessity. Mr. A.P. Deshpande, Honorary Secretary, Marathi Vidnyan Parishad, inaugurated the workshop by emphasing the need of performing experiments in teaching/learning process in science subjects. He appealed teachers to build a bridge between classroom and house to make the

contd on page... 24

(From L to R) Shri A.P. Deshpande, Shri M.V. Kamath and Dr. Subodh Mahanti

Inside

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

Published and Printed by Dr. Subodh Mahanti on behalf of Vigyan Prasar, C-24, Qutab Institutional Area, New Delhi - 110 016 & Printed at Saurabh Printers Pvt. Ltd., B-280, Okhla Industrial Area, Phase - I, New Delhi - 110 020
Editor : Dr. V.B. Kamble

Two Centenaries and a Golden Jubilee

The year 2004 marks the death centennial of Jamsetji Nusserwanji Tata, the founder of the Tata Group and the birth centennial of Jehangir Ratanji Dadabhoy Tata. Both were great nation builders whose contribution in industrializing India and making her self-sufficient in basic areas in the twentieth century has been unparalleled. Both were visionaries with a firm belief that the social and economic development of a country is closely linked with self-sufficiency and the self-reliance arising out of the scientific and technological advances made by the country.

Jamsetji Nusserwanji Tata was born on 13 March, 1839 into a clerical Parsi family in Navsari, Gujarat. Jamsetji Tata created the foundations of Indian enterprise. Indeed, this was an expression of pride that the country could do something, that it could make textiles, manufacture steel, and generate power.

He adopted international standards. He was a true internationalist in that sense and, yet, a committed nationalist. His goal of political and economic self-sufficiency had the effect that the British did not raise him to the rank of nobility as they did with other Parsi entrepreneurs. He faced opposition from the government for many of his projects, including the founding of the steel industry. However, his vision of the Institute of Science in Bangalore, a steel plant in Jamshedpur, and a hydroelectric company were brought to fruition by his successors. He once said, " Freedom without the strength to support it and, if need be, defend it, would be a cruel delusion. The strength to defend freedom can itself only come from widespread industrialisation and the infusion of modern science and technology into the country's economic life". He died on May 19, 1904 in Bad Nauheim, Austria.

Jehangir Ratanji Dadabhoy Tata, or JRD as he was popularly called, was born on 29 July, 1904 in Paris and spent much of his childhood in France. His father was Ratanji Dadabhoy Tata, a cousin of Jamsetji Nusserwanji Tata. JRD was a committed nationalist. He was proud of India and tremendously passionate about building a vibrant nation with an open economy and a free-enterprise structure. He shaped the Tata Group. He was at the helm of affairs of Tata & Sons for over fifty years. Under his stewardship, it became India's largest industrial empire with number of ventures growing from 13 to about 80. Tata Chemicals, Tata Engineering and Locomotive Company (TELCO), and Tata Consultancy Services were only a few of his creations.

Flying was true love of JRD. His passion for flying was fulfilled with the formation of the Tata Aviation Service in 1932. The first flight of Indian Civil aviation took off at Drigh Road airfield in Karachi on October 15, 1932, with JRD himself at the controls of the Puss Moth that he flew solo to Ahmedabad and onwards to Mumbai (then Bombay). After India gained independence, Air India International was formed as a joint sector company. Equally historic was his role in launching India into the age of nuclear science by lending support to Homi Bhabha in the establishment of Tata Institute of Fundamental Research. He was also on the Board of the Atomic Energy Commission since its inception in 1977. Tata Memorial Hospital in Mumbai established by him carries out triple objects of treatment, research and education. He played the part of statesman in India and abroad and even espoused causes like family planning and the plight of the girl child. He died on 29 November,1993 in Switzerland.

The year 2004 also marks the fifty years of the "Madras Triple Helix", the molecular model proposed for the fibrous protein collagen by Professor Gopalasamudram Narayana Ramachandran (08 October, 1922 - 07 April 2001), physicist turned outstanding structural biologist, and his group. About one quarter of all of the protein in our body is collagen. Collagen is a major structural protein, forming molecular cables that strengthen the tendons and vast, resilient sheets that support the skin and internal organs. Though collagen is a relatively simple protein, its structure remained a mystery till 1954.

After his Bachelor's (Honours) degree in physics, Ramachandran joined the Department of Physics, Indian Institute of Science, Bangalore, the Institute founded by Jamsetji Nusserwanji Tata. He worked with Sir C. V. Raman. Ramachandran worked on a number of problems related to light scattering, optics, crystal perfection and so on. Ramachandran spent two years at the Cavendish Laboratory before returning to India to become Professor and Head of the Department of Physics, University of Madras in 1952. It is here he completely shifted his interest to the application of X-ray diffraction to the study of biomolecules. It is part of history that the young Ramachandran along with G. Kartha within a span of two years proposed the triple helical structure for collagen. Incidentally, this was just a year after the double helical structure for DNA by Watson and Crick was propounded. Ramachandran thus joined the big league of structural biologists when he was hardly 32. Ramachandran went on to enunciate the fundamental stereochemical principles for conformational analysis of proteins through the famous Ramachandran plot.

Ramachandran received many honours from India and abroad. He was elected Fellow of the Royal Society in 1977.

contd on page... 19

Editor : **V.B. Kamble**

Address for correspondence : Vigyan Prasar, C-24, Qutab Institutional Area, New Delhi-110 016; Tel : 26967532; Fax : 26965986
e-mail : vigyan@hub.nic.in
website : http://www.vigyanprasar.com

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.

Upendra Nath Brahmachari

A Pioneer of Modern Medicine in India

❒ Subodh Mahanti
e-mail: mahantisubodh@hotmail.com

"As a matter of the most vital concern in nation-building, the problem of nutrition demands very careful consideration by statesmen and scientists alike, more so due to the fact, as has been recently observed, that a great part of the world's population is not consuming the necessary food stuff. An eminent Swiss authority predicts the decay of civilization unless there is a fundamental revision of the people's diet.

Upendra Nath Brahmachari in his General Presidential address to the Indian Science Congress (1936).

"The progress in the campaign against Kala-azar in Assam has been phenomenally rapid and if it continued at the present rate there is excellent prospect of the dread scourge being brought under complete control in a few years. Dr. Brahmachari's researches in the treatment of Kala-azar were one of the most outstanding contributions in tropical therapeutics, as a result of which three lakhs of human lives were saved in the Province of Assam during the course of ten years."

Sir John Kerr, the then Governor of Assam in his farewell address to the Assam Legislative Council referring to the value of Stibamine, discovered by Brahmachari.

"Dr. Brahmachari has been the President of the Asiatic Society of Bengal for three times; has done extensive research in connection with tropical diseases such as malaria, blackwater fever etc., and as a research worker enjoys international reputation; recognized as a leading expert on Kala-azar in particular, in the treatment of which he has achieved remarkable success with his `Urea Stibanmine' which he discovered; has earned a name in philanthropy; is one of the most eminent physicians in Calcutta and is held in esteem also by laymen of all communities."

The then Viceroy of British India at Brahmachari's Investure of Knighthood.

Upendra Nath Brahmachari was a leading medical practitioner of India of his time. His monumental discovery of Urea Stibamine, an organic antimonial compound, played a crucial role in the treatment of and campaign against Kala-Azar. His "Treatise on Kala-azar" is a premier work on the subject. As a teacher and educationist his work was of a high order. He was associated with almost all the known scientific and literary organizations at Kolkata. He had an insatiable thirst for knowledge. He had large private collection of books, which included not only scientific works but also literary works. Brahmachari was a remarkable personality.

Upendra Nath Brahmachari

Upendra Nath Brahmachari was born in Jamalpore, in the Monghyr district of Bihar to Dr. Nilmony Brahmachari and Smt. Sourav Sundari Devi. His official date of birth was June 07, 1875. However it has been reported that Brahmachari, in his later life mentioned his actual date of birth 19 December, 1873. In those days Jamalpore was an important railway town of the then East Indian Railways. His father was a medical man and served the East India Railways at Jamalpore. As a physician he was very successful. Dr. Nilmony's name was a household word at Jamalpore. He was a highly respected figure in both the European and Indian communities. After his retirement from the services of the railways Dr. Nilmony became a Municipal Commissioner and an Honorary Magistrate of Jamalpore.

The title Brhamachari has a little history. A person who lives a life of celibacy is called Brahmachari. It was Keshav Bharati who had initiated Sri Chaitanya Mahaprabhu into Sanyas. Keshav Baharati himself had taken Sanyas under the Bharati sect of Sri Shankaracharya. Thus he had no descendants of his own. Keshav's elder brother Gopal had taken deeksha from him. Gopal renounced his family title of Mukhopadhyaya and became known as Gopal Bharati Brahmachari Thakur. Brahmachari's ancestors were descendants of Gopal Bharati Brahmachari, he being in the ninth line of descent.

Brahmachari had his early education at the Eastern Railways Boys' High School at Jamalpore. After passing his Entrance Examination from Jamalpore with credit, Brahmachari joined the Hooghly College, from where he passed his BA in 1893, with Honours in Mathematics and Chemistry. In those days it was possible for a student to appear in two honours subjects. Brahmachari stood first in order of merit in Mathematics in his BA examination and awarded the Thwyates Medal. Though Brahmachari loved Mathematics deeply and had shown great proficiency in the subject, he decided to join the Calcutta Medical College and the Presidency College at Kolkata (then Calcutta) for studying Medicine and Chemistry respectively. He passed his M.A. degree with First Class in Chemistry from the Presidency College in 1894.

He was taught chemistry by Sir Alexander Pedler and Acharya Prafulla Chandra Ray. Brahmachari was greatly influenced by Acharya Ray. Brahmachari also pursued his medical career with equal diligence. He obtained his L.M.S degree in 1899 and in the next year he took the MB degree. In his MB Examination Brahmachari stood First in Medicine and in Surgery and for which he was awarded Goodeve and McLeod Medals. In 1902 he obtained the MD degree of the Calcutta University. In those days it was a rare distinction. He also obtained Ph.D. degree of the Calcutta University for his researches in Physiology. His thesis was titled Studies in Haemolysis, a work, which even today is considered an important piece of work on physiological and physiochemical properties of the Red Blood Cells.

Acharya Prafulla Chandra Ray by whom Brahmachari was deeply influenced

After a firm grounding in Mathematics, Chemistry, Physiology and modern Medicine, Brahmachari joined the Provincial Medical Service in September 1899. For a brief period he worked as the House Physician in the Ward of the First Physician Sir Gerald Bomford's. Sir Bomford was highly impressed with young Brahmachari's urge for carrying out research and his strong sense of duties. Bomford got Brahmachari appointed as Teacher of Physiology and Materia Medica and Physician in Dacca Medical School in November 1901. He spent about four years at Dacca. During this short period he had established himself as an excellent teacher, a medical practitioner and a consultant. He also did researches with Sir Neil Campbell, Superintendent of the Medical School. After coming back to Kolkata in 1905, Brahmachari joined the Campbell Medical School (now renamed as Nil Ratan Sarkar Medical College and Hospital) as the Teacher of Medicine and First Physician. The most important part of his life was spent at the Campbell Medical School, where he spent 20 years. In 1923 Brahmachari joined the Medical College, Kolkata as Additional Physician. It may be noted here that Brahmachari and Lt. Col. K. K. Chatterjee were the first two Provincial Medical Service men outside Indian Medical service cadre, to get appointments in the Medical College. Lt. Col. Chatterjee had joined as Additional Surgeon. Brahmachari retired from the Government Service at the Medical College in 1927. After retirement from the Government service Brahmachari joined the Carmichael Medical College as Professor of Tropical Diseases. He also served the National Medical Institute as In-charge of its Tropical Disease Ward. He also became the Head of the Department of Biochemistry and Hony. Professor of Biochemistry at the University College of Science, Kolkata.

Brahmachari's most outstanding research contribution was in the field of conquest of Kala-Azar (a Hindi term for black fever), a protozoal infection in both children and adults. The disease Kala-azar (Visceral leishmaniasis) was described by William Leishman and Charles Donovan in 1903. Kala-azar is also known as Leishman-Donovan infection. Kala-azar is an infectious disease of South Asian and Mediterranean countries. The protozoan parasite that causes the disease is called Leishmania donovani. The disease is transmitted by sand flies and it is characterised by an enlarged spleen and liver, irregular fever, anemia etc. Though various forms of treatment were in vogue but they did not help to reduce the death rate. In 1913, a Brazilian doctor named Vianna reported to have cured the South American form of Kala-azar by the intra-venous administration of tartar emetic (potassium salt of antimonyl tartrate). Then in 1915 Christina and Cortina of Sicily also recorded the successful use of tartrate emetic in infantile Kala-azar. Rogers in Calcutta also obtained favourable results in 1915, by the intra-venous use of tartar emetic. However, physicians soon found that there were serious disadvantages in the prolonged use of tartar emetic intra-venously. Brahmachari decided to improve the results over tartar emetic by using the sodium salt of antimonyl tartrate instead of the potassium salt. By doing this Brahmachari thought that he would avoid the depressant action of potassium and so he would get better results. He did get better results and used sodium antimonyl tartrate for years. It was found later that prolonged use of the sodium salt had also disadvantages. Brahmachari started using metallic antimony—first as fine powder and then as colloidal antimony. Both forms of antimony used by Brahmachari gave good results but they had the following disadvantages:

i. They were not readily available.
ii. As they could not be stored for a long time they had to be prepared afresh every time.
iii. The method of their preparation was tedious.
iv. The technique of their intravenous administration was quite complicated.

Seeing these disadvantages Brahmachari continued his search for a more efficient means of treatment of Kala-azar. Around this time Ehrlich was successful in treating sleeping sickness by using atoxyl or sodium salt of para-arsanilic acid. Brahmachari decided to replace arsenic of atoxyl by antimony and then use this compound for treatment of Kala-azar. Antimony was the causative agent and both arsenic and antimony belong to the same group of the Periodic Table. There were other people who were working on the similar idea. Towards the end of 1919 Brahmachari received a grant from the Indian Research Fund Association for conducting further research into the treatment of the disease. He carried out his research work in a small ill-equipped room in the Campbell Hospital. He did not have even simple facilities

like a gas burner, a water tap or an electric bulb. Working under such adverse conditions Brahmachari discovered a potent agent against Kala-azar, which he named Urea Stibamine. It was the urea salt of para-amino-phenyl stibnic acid. Recalling the moment of his important discovery he later wrote: "I recall with joy that memorable night in the

The tablet erected in Brahmachari's honour on one of the walls of the room of the Campbell Medical School.

Calcutta Campbell Hospital at Sealdah where after a very hard day's work I found at about 10 o'clock in a little room with a smoky dimly burning lantern that the results of my experiments were up to my expectations. But I did not know then that providence had put into my hands a wondrous thing and that this little thing would save the lives of millions of fellowmen.

I shall never forget that room where Urea Stibamine was discovered. The room where I had to labour for months without a gas point or a water tap and where I had to remain contented with an old kerosene lamp for my work at night. The room still remains but the signs of a laboratory in it have completely disappeared. To me it will ever remain a place of pilgrimage where the first light of Urea Stimamine dawned upon my mind.

To-day Urea Stibamine stands pre-eminent in the treatment of Kala-azar in India and as a powerful prophylactic against the disease. And it is a matter of supreme satisfaction to me that the treatment evolved out of my research has removed the terrors of this distressing disease. It may be hoped that before long the disease will be completely banished from India and other parts of the world where it occurs. That will be happiest and proudest day of my life if it falls to my lot to see it."

Urea Stibamine was a great success in treating Kala-azar. In 1932, Col. H. E. Short, Director, Kala-azar Commission, appointed by the Government of India stated: "We found Urea Stibamine an eminently safe and reliable drug and in seven years we treated some thousands of cases of Kala-azar and saw thousands more treated in treatment centers. The acute fulminating type characteristic of the peak period of an epidemic responds to treatment extraordinarily promptly and with an almost dramatic cessation of fever, diminution in the size of spleen and return to normal condition of health." Today the incidence of Kala-azar has drastically reduced in India and other parts of the world. There are occasional or sporadic cases here and there. Today Kala-azar persists only in very poor and remote areas.

Though mostly known for his brilliant work on Kala-azar, Brahmachari worked on other diseases like Malaria, Black-Water Fever, Cerebrospinal Meningitis, Diabetes, Filariasis, Influenza, Leprosy, and Syphilis. He published about 150 research papers. Brahmachari was the first to discover the presence of Qurtartan Fever in Kolkata and Dhaka. This disease was considered to be very rare. Crombie, the President of the Indian Medical Congress (1894) stated in his Presidential Address that he had met only one case in his whole experience in India. Brahmachari, after a most exhaustive and critical survey of the vast literature on the Old Burdwan Fever, concluded that the disease was a combination of two diseases namely malaria and Kala-azar. He published his conclusion in his paper, "On the nature of the epidemic fever in Lower Bengal commonly known as Burdwan Fever" published in the *Indian Medical Gazette* in 1911. Brahmachari had shown that in Black-water Fever the largest amount of haemolysis occurred in the liver during the active stage of the disease. He also prepared an anti-haemolytic solution of quinine for treatment of cases of black-water fever whose blood showed the presence of malarial parasites.

In his Presidential Address to the Asiatic Society of Bengal in 1930 Brahmachari said: "When I recall to my mind that I had the privilege of teaching and examining many hundreds of medical students in Medicine, and remember the raw and restive youths to whom I lectured, and then look around and see the resulting product, I feel with Sir Ernest Rutherford that a transformation has occurred that is much more wonderful than the transformation of radium and must have involved much more energy in the process…India, the seat of earliest civilization of man, is regaining the healthy state that she must have enjoyed in the days of old. Diseases which for many centuries were considered incurable and destroyed millions of human lives in India, are now losing their terrors."

Brahmachari was actively connected in various spheres in the University of Calcutta for nearly 40 years. He was Fellow of the Calcutta University since the beginning of the Universities Act 1904. He was a member of the Senate, the

Syndicate and Boards of Studies of Medicine and of Science of the Calcutta University. He was also the Dean of the Faculty of the Medicine (1938) and Dean of Faculty of Science (1938-40). He was a Active Member in the Rules Revision Committee responsible for framing the University Regulations from the beginning of the Universities Act 1904.

Around 1924, Brahmachari had established a research institute in his own residence in Cornwallis Street, Kolkata. This institute was later converted into a Partnership concern with his sons Phanindra Nath and Nirmal Kumar. Under his guidance the Institute did remarkably well both in the fields of research and manufacture. Unfortunately the institute stopped functioning in 1963 and the nation lost a legacy of one of its great sons.

A view of the room in the Campbell Medical school where Brahmachari worked.

Brahmachari took keen interest in humanitarian and cultural activities. He played an important part in the formation of a Blood Bank at Calcutta. He was the Chairman of the Blood Transfusion Service of Bengal. He was the Vice President of the St. John Ambulance Association of the Bengal branch and also its President. He was the Chairman of the Managing Body of the Indian Red Cross Society of the Bengal Branch. In fact he happened to be its first Indian Chairman. He was a member of the Sanitary Board of Bengal. He was the Vice-Chairman of the Board of Trustees of the Indian Museum.

He was a charitable person. He made generous donations. Among the public institutions which received donations from Brahmachari are: The Indian Red Cross Society, The Blood Bank at Kolkata, the University of Calcutta, the Jadavpur Tuberculosis Sanatorium, the Central Glass and Ceramic Research Institute, the Physiological Society of India, Calcutta Medical College, the Indian Association for the Cultivation of Science, Indian Science Congress, Vicerroy's Earthquake Relief Fund, Lady Jackson's Darjeeling Victoria Hospital Fund, and Board of Industries of Bengal. There was hardly any hospital in India that did not get free gift of his Urea Stibamine. He sold urea stibamine to the government at his cost price. He had made provisions for several awards, scholarships and medals for the University of Calcutta. Many people do not know that the journal "Science and Culture" could be initiated because of a generous donation from Brahmachari. He generously contributed to the High School in Purbasthali near his ancestral home. The name of of the institution was later changed in the name of his father as Purbasthali Nilmoy Brahmachari Institution.

Among the various honours that he received included: the Griffith Memorial Prize of Calcutta University; the Minto Medal of the School of Tropical Medicine & Hygien; the Kaiser-I-Hind Gold Medal; the Sir William Jones Medal of the Asiatic Society of Bengal. He was felicitated and honoured by various medical and scientific bodies. He was: President, Indian Association of the cultivation of Science; Calcutta; President, society of Biological Chemists; President, Indian Committee of International Microbiological Congress, Paris; President, Physiological Society of India; President, Indian Science Congress; President, Asiatic Society of Bengal; President, Indian Science News Association, Calcutta; President, Indian Provincial Medical Service Association; Fellow, Royal Society of Medicine, London; Fellow, Royal Society of Tropical Medicine and Hygiene, London; Hony. Fellow International Faculty of Science, London; Fellow National Institute of Sciences of India (Later renamed Indian National Science Academy).

The then British Government recognized the importance of Brahmachari's work. He was awarded the title of Rai Bahadur for his multifarious, humanitarian and other works. He was knighted in 1914.

He was a very good host. He used to love to entertain people. *Lancet* in its March 09, 1946 issue wrote: "In his large house in Calcutta, Brahmachari delighted to entertain his British and Indian friends. The fare was always good and the conversation even better. If all distinguished Indians, and for that matter all British officials, had shared his liberal outlook, many of the difficulties of India today would have been solved before they have time to develop."

Brahmachari died on February 06, 1946.

Some Important works by Upendra Nath Brahamcarhy

1. Studies in Haemolysis, Calcutta University, 1909.
2. Kala-Azar : Its treatment, Butterworth & Co. Ltd. Calcutta 1917.
3. Kala-Azar in Doctor Carl Mense's Handbuch der Tropenkranahaiten, vol. IV, 1926.
4. Treatise on Kala-Azar, John Bale, Son's & Danielsson Ltd., London, 1928.
5. Campaign against Kala-Azar in India, Jubilee Publication on the 80th birthday of Dr. Prof. Bernhard Nocht, Hamburg, 1937.
6. Progress of Medical Research work in India during the last 25 years, an progress of Science in India, during the past 25 years, Indian Science Congress Association 1938.
7. Gleanings from my Researchers Vol. I, Calcutta University 1940
8. Gleanings from my Researchers Vol. II Calcutta University 1941
9. Infantile Biliary Cirrhosis in India in British Encyclopedia of Medical practice. Edited by Sir Humphrey Rolleston

References

1. Biographical Memoirs of Fellows of the Indian National Science Academy Vol. 4. New Delhi: Indian National Science academy, 1976.

◆◆◆

Our Food

A Potential Source Of Carcinogens Or Anti-carcinogens?

❒ K. Srinivasan
e-mail:ksri@sancharnet.in

Oxygen radicals produced in our body cells during normal oxidative metabolism play a major role as endogenous initiators of degenerative processes related to cardiovascular disease, inflammatory disease, aging, and to DNA damage, mutation and promotion leading to cancer. These reactive chemical species that contain one or more unpaired electrons and include superoxide anion radical, hydrogen peroxide, hydroxy radical, singlet molecular oxygen, and alkoxy and peroxy radicals readily react with DNA, lipids, and proteins present in the cells. Such attacks can damage the cell or can cause changes in genes. While free radicals can also be generated during tissue injury, infections, excess exercise and specific types of food preparation, a variety of environmental agents (radiation, air pollution, and cigarette smoke) could trigger their production and hence contribute to the body's oxygen radical load. Polyunsaturated fatty acids present in membranes are compounds that have great potential for activation *in vivo* to form free radicals. Mutation, which is a site-specific alteration in the DNA strand of the gene, is the primary mechanism by which cancer is caused, a disease in which cells multiply wildly, destroy healthy tissue, and endanger life. Any chemical agent that produces mutation is known as mutagen, and the one that also leads to cancer is carcinogen. Fortunately, every mutation will not result in cancer, since there is an endogenous DNA-repair mechanism; at the same time there are agents (promoters) which interfere with such a repair mechanism, thus promoting the progression from mutation to cancer.

Lifestyle and Environmental Cancer Threats

Lifestyle and environmental factors play a major role in the etiology of human cancer. Cancer is a disease that affects the lungs, organs of the digestive system, skin, prostate and breasts, and is the leading cause of death in many countries. About 30% cancer deaths are due to tobacco smoking (apart from 25% fatal heart attacks) in USA. Excessive alcohol consumption is another risk though to a lesser extent than smoking. High-dosage exposures to other specific agents could be a vital cause factor for particular groups of people; for e.g., certain drugs whose consumption can be hundreds of milligrams per day, particular cosmetics, and certain occupational exposures where workers inhale dusts or solvents at high concentration (e.g., asbestos, coal, aniline dyes, benzene, vinyl chloride, etc.).

Dietary factors considered posing cancer risks

Apart from life style and environmental factors, dietary practices have been believed to be one of the important determinants of cancer risks. Some chemicals naturally present in our food may become a cancer threat if consumed in large quantities, as they are potential mutagens and carcinogens. Diets high in fats, for example, have been associated with cancers of the breast, colon, and prostate gland. Some studies have linked eating large amounts of salt-cured, salt-pickled, and smoked foods to cancers of the digestive system. Moulds that sometimes develop on food crops such as corn and peanuts are also believed to contain carcinogens. Some substances (insecticides or agents to control weeds) that are added or applied to plants are also presumed to cause cancer in human beings. Recent widespread use of short term tests for detecting mutagens and the increased number of animal cancer tests on plant materials have contributed to the identification of many natural mutagens, teratogens (agents that cause defective development of organs in the offspring) and carcinogens present in human diet. But the identification of a substance whether natural or man-made, as a mutagen / carcinogen is only the first step. Even if the cancer producing potential of a substance is evidenced in animal studies, extrapolation of such a risk from laboratory rodent models to humans is imprecise for many reasons, including longevity difference, and the probable multicasual nature of most human cancer. Those toxic chemicals of plant origin are synthesized apparently as a primary defense against hordes of bacterial / fungal infestation or insect and animal predators. Human dietary intake of natural toxic chemicals is likely to be several grams per day, which is probably 10,000 times higher than the dietary intake of man-made pesticides.

Alcohol: Alcohol consumption has been associated with cancer of the mouth, esophagus, pharynx, larynx, and to a lesser extent, liver. Alcohol is also a teratogen causing a variety of physical and mental defects in babies of drinking mothers. Alcohol drinking has been evidenced to cause sperm abnormalities in rodents and is a synergist for chromosome damage in humans. Alcohol metabolism generates acetaldehyde, which is a mutagen and teratogen, a cocarcinogen, and possibly a carcinogen. Alcohol also yields radicals that produce lipid hydroperoxides and other mutagens and carcinogens.

Fat: Epidemiologic studies of cancer in humans suggest that high fat intake is associated with colon and breast cancer. A number of animal studies have shown that high dietary fat is a promoter and a presumptive carcinogen. The deleterious influence of high fat is mediated through generation of higher amounts of oxygen free radicals than the body can cope up with. Fat constitutes over 40% of calories in US diet and hence the amount of ingested oxidized fat may be appreciable. Unsaturated fatty acids and cholesterol in fat are easily oxidized, particularly during cooking. The lipid peroxidation chain reaction (rancidity) yields a variety of mutagens, promoters and carcinogens such as fatty acid hydroperoxides, cholesterol hydroperoxide, endoperoxides, cholesterol epoxides, fatty acid epoxides, enals and other aldehydes, and alkoxy and hydroperoxy radicals. Peroxisomes of the cell oxidize an appreciable portion of dietary fatty acids, and removal of each two-carbon unit generates one molecule of hydrogen peroxide (a mutagen, promoter, and carcinogen), that is usually inactivated by the enzyme catalase also present in peroxisomes. Oxidation of fatty acids of dietary fat might generate grams of hydrogen peroxide per day within the peroxisome. Some hydrogen peroxide escapes the catalase-mediated inactivation, thus contributing to the supply of oxygen radicals. Hydroperoxides generate oxygen radicals in presence of iron containing compounds in the cell. Oxygen radicals, in turn can damage DNA and can start the rancidity chain reaction leading to the production of the mutagens and carcinogens.

Burnt and brown food material: Burnt and brown food material formed from heating protein during cooking is highly mutagenic. Several chemicals isolated on the basis of their mutagenicity from heated protein or pyrolyzed amino acids have been shown to be carcinogenic in rodents. In addition, the browning reaction products from caramelization of sugars (reaction of amino acids and sugars during cooking), e.g., the brown color on bread crusts and toasted breads, contain a large variety of DNA-damaging agents and presumptive carcinogens. The amount of burnt and brown material in the human diet may well amount to several grams per day (As compared to about 0.5 g of burnt material inhaled each day by a 2-pack / day smoker). Just like smokers, people consuming a meal of burnt food material (such as fried pork or beans) will have easily detectable levels of mutagens in their urine. Coffee, which contains a considerable amount of burnt material, including the mutagenic pyrolysis product methylglyoxal, is mutagenic.

Mold carcinogens: A variety of mold carcinogens and mutagens are present in mold-contaminated foods such as corn, grain, nuts, peanut butter, bread, cheese and fruits. Aflatoxin and sterigmatocystin are the important mold carcinogens.

Nitrite, nitrate and nitrosamines: A number of human cancers such as stomach and esophagal cancer may be related to nitrosamines and other nitroso compounds formed from nitrate and nitrite in the diet. Beets, celery, lettuce, spinach and radish contain upto 200 mg% nitrate.

Miscellaneous phytochemicals: In addition, there is more than a dozen naturally occurring plant food chemicals that account for dietary intake of nature's toxic compounds. These include: (1) Safrole, estragole and methyl eugenol present in many edible plants. Safrole is mainly present in the roots of sassafras, and in lesser amounts in spices - black pepper, nutmeg, mace, star anise oil, cinnamon leaf oil, cocoa and parsley. Estragole is present in the essential oil of terragon, fennel, basil and turpentine while eugenol is present in essential oils of clove, cinnamon and allspice. (2) Hydrazines present in edible mushrooms. Three out of 11 hydrazines present in False Morel (*Gyromitra esculenta*) are carcinogens; e.g.N-methyl-N-formyl hydrazine (50 mg%). *Agaricus bisporus* has 300 mg% agaritine (d-glutamyl derivative of 4-hydroxymethyl phenylhydrazine). Hydrazine carcinogens may act by producing oxygen radicals. (3) Furocoumarins wide-spread in plants of *Umbelliferae* family (e.g. celery, parsnip, and parsley) are potent light-activated carcinogens and mutagens. Parsnip (4 mg%); Celery (0.1 mg%); Sporalen is rich in bergamot, a citrus oil (used in suntan lotion). These furocarcinogens produce oxygen radicals in presence of light. (4) Glycoalkaloids - solanine and chaconine present in potato (8mg%) are strong cholinesterase inhibitors and possible teratogens. When potatoes are diseased, bruised or exposed to light, these glycoalkaloids - toxic chemicals produced as a defense against insects and fungi reach levels that can be lethal to humans. (5) Quercetin and related flavonoids, extremely widespread in human diet (upto 1 g per day) are shown to be mutagens and even as carcinogen in rats. (6) Quinones and their phenol precursors, widespread in human diet are shown to be mutagens. Quinones can act as electrophiles and accept a single electron to yield semiquinone radical, which can either react directly with DNA or generate a superoxide radical by transferring the electron to O_2. The superoxide radical and its metabolic product H_2O_2, can in turn lead to oxidation of fat in cellular membranes by a lipid peroxidation chain reaction, thus generating mutagens and carcinogens. Many dietary phenols can

spontaneously autooxidize to quinones, generating H_2O_2, e.g. caffeic acid - component of chlorogenic acid (250 mg / cup of coffee). Caffeine present in coffee is believed to prevent the DNA repair system and hence promote tumor yield. Epidemiological evidence indicates that heavy coffee drinking is associated with cancer of the ovary, bladder, pancreas and intestine. Catechol (widely present) is a potent promoter of carcinogenesis. (7) Theobromine present in cocoa (2%), an analog of caffeine is shown to be genotoxic. Its human consumption may be hundreds of milligrams per day from chocolates. (8) Pyrrolizidine alkaloids present in many plant species (human consumption mainly through use of herbal tea) are carcinogenic, mutagenic and teratogenic. (9) The broad bean (*Vicia faba*), a common food of Mediterranean region contains toxins - vicine and convicine at ~2% dry weight. (10) Allyl isothiocyanate, a flavour ingredient of oil of mustard and horseradish is shown to be carcinogenic in rats and cause chromosome aberrations in hamster cells. (11) Gossypol is a major toxin in cotton seed (1% by dry weight) found to be a potent initiater and also a promoter of carcinogenesis in mice. Its human consumption may be appreciable in countries such as Egypt where fairly crude cottonseed oil is used in cooking. It is also known to cause sterility in males and used as an oral contraceptive for men (10 mg/day) in China. Its spermicidal action may be through production of oxygen radicals. (12) Sterculic acid and malvalic acid (widespread in human diet) are toxic cyclopropanoid fatty acids present in cottonseed oil. Human exposure could be due to consumption of milk from animals fed cottonseed. These compounds are known to be carcinogens through formation of peroxy radicals. (13) Leguminous plants such as lupine contain very potent teratogens. e.g. Anagyrine, whose maternal intake affects the new born calves. Besides, these teratogens are transferred to the animal's milk, and drinking such milk during pregnancy is a serious teratogenic hazard. (14) Sesquiterpene lactones, widespread in plants are shown to be mutagenic. (15) Phorbol esters present in *Euphorbiacea* are potent promoters of carcinogenesis, and their human exposure occurs through herbal remedies and herbal tea (especially in China). (16) Canavanine (Amino-iminomethylamino homoserine) is a highly toxic arginine analog present in Alfalfa sprouts (1.5%) that gets incorporated into proteins in place of arginine. The canavanine - Alfalfa sprout pathology could be due in part to the production of oxygen radicals during phagocytization of antibody complexes with canavanine containing protein.

Desmutagens and anti-carcinogens in food

Our body has evolved several defense mechanisms to protect itself against mutagens and carcinogens, including shedding of the surface layer of our skin, stomach, cornea, intestines and colon. Among these, the defense mechanisms that deal directly with oxygen radicals - hydrogen peroxide and superoxides generated as side products of metabolism, and the oxygen radical burst from phagocytosis following viral or bacterial infection or the inflammatory reaction and lipid peroxidation are the most important ones.

Antioxidants are those agents, which restrict the deleterious effects of oxidant reactions. These effects can be direct (eliminating free radicals) or indirect (preventing free radical formation). The first category of antioxidants (Desmutagens) protect cells from the effects of free radicals, by inactivating these mutagens by providing an electron to them before they attack important cell structures. The body naturally produces certain enzymes (antioxidant enzymes) that act as antioxidants also by inactivating the free radicals. Antioxidants may exist in the body (e.g. Antioxidant enzymes) or are ingested with food (Vitamin E, Vitamin C, b-Carotene, flavonoids). There is another group of agents, which reduces the frequency of spontaneous or induced mutations indirectly by interfering with cellular mutagenesis *in vivo*. These act by inhibiting the formation of mutagens from precursors or by inhibition of metabolic activation of mutagens and are called bio-antimutagens.

Dietary anticarcinogens: Certain vitamins, micronutrients, and fibre favourably affect the incidence of cancer. Many non-nutrient components of plants having health beneficial influence, especially chemopreventive property, have now been recognized. These naturally occurring chemical substances / phytochemicals (both non-nutritive, and some nutritive) of fruits, vegetables, grains, nuts and tea may prevent or reduce the risk of chronic diseases - cancers and of cardiovascular disease as well. Besides their nutritive contributions to the diet, the antioxidant vitamins E and C, vitamin A precursor - η-carotene and the trace mineral selenium are known to inhibit carcinogenesis. In addition, a variety of small molecules in our diet such as glutathione, uric acid and phenolics which also act as antioxidants appear to be anticarcinogens.

(a) Vitamin E (ζ-tocopherol), being lipophilic remains in the phospholipid layers of cell membranes, and by its potent antioxidant effect acts as a major radical trap in lipid membranes protecting the PUFA from free radical attack. It is shown to ameliorate mutagenicity and carcinogenicity of quinones (Adriamycin and Daunomycin). Protective effects of tocopherols against radiation-induced DNA damage and mutation, and dimethylhydrazine-induced carcinogenesis have also been observed. Vitamin E has also been reported to reduce the risk of cancers of the breast, GI tract, esophagus, mouth and pharynx. Vitamin E is shown to markedly increase endurance during heavy exercises which cause extensive oxygen radical damage to tissues. Highest quantities of vitamin E are found in vegetable oils and wheat germ and its recommended daily allowance (RDA) is 10 mg per day.

(b) Ascorbic acid (Vitamin C) present in every cell is an aqueous antioxidant which scavenges water-soluble superoxides and hydroxyl radicals. Vitamin C has also been reported to function as a chain-breaking antioxidant in lipid peroxidation. Through these antioxidative mechanisms ascorbic acid may reduce the cancer risks. It is shown to be anticarcinogenic in rodents treated with u.v. radiation, benzo(ζ-)pyrene and nitrite (forming nitroso carcinogens). Its low intake is associated with human uterine cervical cancer. The RDA for ascorbic acid, which is abundantly found in citrus fruits, raw vegetables and sprouted legumes is 60 mg / day.

(c) Carotenoids are antioxidants having been shown to be effective chemopreventors in many animal models and epidemiological studies. η-Carotene in the diet could be important in protecting body fat and lipid membranes against peroxidation. Carotenoids are free radical traps and remarkably efficient quenchers of singlet oxygen a very reactive form of oxygen particularly effective at causing lipid peroxidation. Carotenoids have been shown to be anticarcinogens in rats and mice and probably in humans too. The mechanism of chemopreventive action involves antioxidant activity (scavenge singlet oxygen), antiproliferation / antiprogression through modulation of hormonal activity. Their protective effects in smokers might be related to the high level of oxidants in both cigarette smoke and tar. η-Carotene is present in yellow-orange vegetables such as carrots, pumpkin, papaya and green leafy vegetables. RDA of η-carotene for normal adults is 5-6 mg.

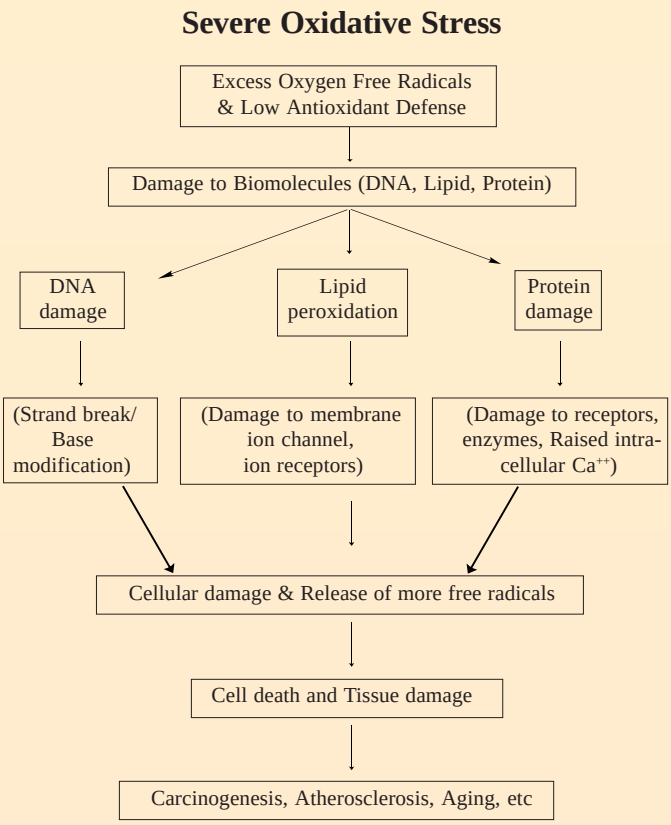
(d) Selenium usually present as selenite is an important dietary trace element having a strong antioxidative property and plays a role in preventing carcinogenesis as well as lowering risk of CVD. It inhibits the induction of skin, liver, colon and mammary tumors in experimental animals by various carcinogenic agents. Selenium is an active constituent of glutathione peroxidase, an antioxidant enzyme essential for destroying lipid hydroperoxides and endogenous hydrogen peroxide. Low selenium concentration may be a risk factor in human cancer. Several heavy metal toxins such as cadmium (a known carcinogen) and mercury lower glutathione peroxidase by interacting with selenium; and selenium has been shown to counter the oxidative toxicity of mercury salts. Selenium is most abundant in beef, egg yolk, seafood, chicken, whole grain cereal, and garlic; its RDA is 0.055 to 0.07 mg per day.

(e) Glutathione present in food is one of the major antioxidants and antimutagens in the soluble fractions of cells. Glutathione transferases are major defenses against oxidative and alkylating carcinogens. The concentration of glutathione may be influenced by dietary sulfur amino acids. Dietary glutathione may be an effective anticarcinogen against aflatoxin.

(f) Uric acid is a strong antioxidant present in high concentration in the blood of humans. Dietary purines increase the concentration of uric acid. Uric acid is also present in saliva and may play a role in defense there as well. A low blood uric acid may be a risk factor for lung cancer in cigarette smoking individuals.

(g) A variety of compounds present in many edible plants have been reported to inhibit carcinogenesis or mutagenesis in experimental animals. These include Allyl sulfides (onions, garlic, leeks, chives), Indoles (cruciferous vegetables - broccoli, cabbage, cauliflower), Isoflavones (Soybeans), Isothiocyanates (cruciferous vegetables), Phenolic acids - Ellagic acid, Ferulic acid (tomatoes, citrus fruits, carrots, whole grains, nuts), Polyphenols (Green tea, black tea, grapes, wine), Terpenes - limonene, perillyl alcohol (cherries, citrus fruit peel) and Curcumin (active coloring principle of the spice - turmeric). These phytochemicals may function via one or more biochemical mechanisms to interfere with or prevent carcinogenesis, including acting as free radical scavengers, enhancing the elimination of potent carcinogens by inducing cytochrome P-450 and other drug metabolizing enzymes.

Phenols occurring very widely in plant foods especially in almost all fresh fruits and vegetables, cereal grains, tea, nuts, and seeds are the largest category of phytochemicals exerting their protective effects against degernerative diseases via antioxidative activity. Three main groups of phenolic compounds are simple phenols and phenolic acids, hydroxycinnamic acid derivatives and flavonoids. These very flavonoids such as quercetin were earlier branded as mutagens based on *in vitro* mutagenecity tests. Isoflavonoids (diphenols) commonly referred to as phytoestrogens especially rich in soybean, (mainly genistein and daidzein; 1-3 mg of glycosides per gm) are understood to reduce some hormonal dependent cancers. Japanese and South-East Asian population have a 4-10 times lower incidence of and death from breast and prostrate cancer than Americans (due to consumption of larger quantity of soy and soy products and attributable to isoflavonoids). Lignans, present in high amounts in seeds and unprocessed soybeans produce hormone like compounds via intestinal bacteria; These metabolites of lignan bind weakly to estrogen receptors and also exhibit antioxidant properties leading to tumor suppressive and anti-tumor property. Phenolic lactone found mainly in berries, walnuts and pecans prevents metabolic activation of procarcinogens, especially nitroso compounds, aflatoxin, polycyclic hydrocarbons via destruction of cytochrome P-450 enzymes, which are responsible for activation of these carcinogens. Carcinogen detoxification is also promoted via the stimulation of glutathione-S-transferase. Hydroxycinnamic acid derivatives found in a wide range of fruits and vegetables include p-coumaric acid, ferulic acid, chlorogenic acid (abundant in coffee), caffeic acid. Chlorogenic acid, caffeic acid and ferulic acid have been found to inhibit nitrosation. Flavonoids (e.g. catechin,



quercetin) abundant in plant kingdom, especially abundant in green and fermented teas are known to scavenge free radicals and modify various enzyme activities. Flavonoids are anticarcinogenic as well, mediated via inhibition of formation or activation of procarcinogen, scavenging of oxygen radicals, etc.

Allylic sulfur compunds (diallyl sulfide, diallyl disulfide, diallyl polysulfide, and S-allyl cysteine) responsible for the typical odor of *Allium* vegetables – garlic, and onion have been known to exhibit chemopreventive qualities. Inhibition of stomach cancer by garlic; inhibition of induced tumors of the stomach, colon, lung, skin in rodents have been documented. These phytochemicals have been reported to prevent the formation of nitrosamines. The reported chemopreventive mechanisms of allylic sulfides include modulation of drug metabolizing enzymes to prevent the metabolic activation of procarcinogens. These compounds also induce the carcinogen scavenger glutathione-S-transferase. Indoles which are phytochemicals (e.g. Indole–3-carbinol) found in cruciferous vegetables (Brussels sprouts, kale, cabbage, broccoli, cauliflower, and spinach); are reported to possess chemopreventive activity especially for hormonal cancers such as breast cancer, through deactivation / detoxification of carcinogens. Isothiocyanates (e.g. phenyl isothiocyanate, benzyl isothiocyanate) found in cruciferous vegetables (Cabbage, Brussel sprouts, Turnips, Radishes, Brococoli and Cauliflower) are anticarcinogenic compounds, being potent inhibitors of nitrosamine induced tumors, attributed to their inhibition of cytochrome P-450 enzymes. Phytic acid present in legumes, oil seeds and cereal bran has cancer preventive influence.

Enzymatic defenses: Several antioxidant enzymes such as superoxide dismutase, catalase, glutathione peroxidase, glutathione transferase, DT-diaphorase endogenously present in our body, protect cells from oxidative damage. (a) Superoxide dismutases ubiquitously present in tissues serve to inactivate superoxides. The enzyme present in cytosol of the cell is a copper and zinc containing enzyme, while the one present within mitochondria is a manganese containing enzyme. In humans, liver has the highest activity of this enzyme while fat tissue the least.

(b) Catalase present in all mammalian cells, mainly compartmentalized in peroxisomes has been established to be efficient in protecting against oxygen free radical attack.

$$2\ H_2O_2 \Downarrow 2H_2O + O_2$$

(c) Glutathione peroxidase, a selenium-containing enzyme can inactivate any hydroperoxide as well as hydrogen peroxide.

$$ROOH \xrightarrow{2GSH\ GSSG} ROH + H_2O$$

$$H_2O_2 \xrightarrow{2GSH\ GSSG} 2\ H_2O$$

The non-selenium containing glutathione transferases exhibit this activity only with organic hydroperoxides. Owing to inaccessibility, only those lipid hydroperoxides that are released from membrane phospholipids (by the action of phospholipases) serve as substrates for these peroxidases.

Oxidative stress occurs when more free radicals are generated than quenched. Some dietary antioxidants are essential nutrients (Vitamin E, Vitamin C, η-Carotene (Body cannot function normally without them) while others - numerous antioxidant phyto-chemicals are non-essential for life, but one might live better with them as they confer health benefits. Hence, it would be a prudent strategy to consume plant foods (especially fruits and vegetables), that provide significant amounts of antioxidant chemicals that act as anticarcinogens and protective factors. The differences in the cancer rates among human population thought to be mainly due to life-style factors, such as smoking and dietary carcinogens and promoters may also be due to less than optimum amounts of anticarcinogens and protective factors derived from their diets.

Dr. K. Srinivasan is Senior Scientist, Department of Biochemistry & Nutrition, Central Food Technological Research Institute, Mysore - 570020

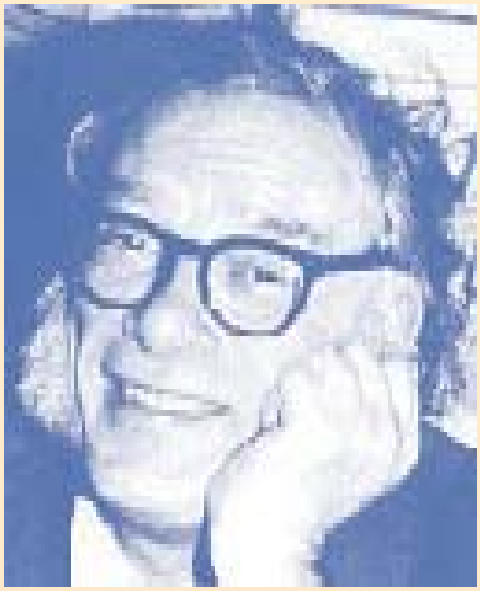
Isaac Asimov

A Genius Science Fiction Writer

P.K Mukherjee

A popular science fiction (SF) writer Isaac Asimov was well read and well acquainted with a number of disciplines like physics, astrophysics, earth sciences, and the life sciences. Besides SF, he also wrote on many facets of science. He wrote extensively on popular themes like space travel, intelligent life in the universe, artificial intelligence, and robotics. It appears that he was specialised in the field of robotics. He enunciated three laws knows as Asimov's laws of robotics.

Asimov was born in Russia near Smolensk in 1920. His father was a petty shopkeeper. In 1923, the Asimov family migrated to the United States and by 1928 Asimov attained an American citizenship. His extraordinary intellect helped him finish high school before he even turned sixteen.



Isaac Asimov

Despite his father's desire to make him study medicine, Asimov joined the Columbia University. In 1939, he graduated from this University in chemistry. However, as the Second World War broke out, he was forced to temporarily leave his studies and join the army. He became a chemist at the Navy Yard in Philadelphia.

After the War ended, Asimov came back to the Columbia University in 1946. He gained his doctorate degree from this University in 1949. He qualified to become an instructor in biochemistry at the Boston University School of Medicine, where he became an Associate Professor in 1955, while researching in nucleic acid. However, the pressure of research and teaching conflicted with his aspiration in the literary field and thus in 1958 he decided to devote his full time to writing.

Asimov's interest in science fiction started when he was a teenager. He would read almost every issue of *Amazing Stories,* a very reputed SF magazine of that time with the utmost interest. Sitting in an isolated corner of his house he would try to write SF stories in his school note books. Asimov's career as a science fiction writer took off in 1939 when his short SF story *Marooned off Vesta* was published in the *Amazing Stories.* After that he never looked back. He became a regular contributor to the leading SF magazines of the day including *Astounding, Astounding Stories, Super Science Stories,* and *Galaxy.*

Asimov's writings spanned for almost five decades. Revolutionary changes were taking place especially in the field of science during the initial decades of his writing. These decades witnessed the emergence of new techniques like X-ray spectroscopy, nuclear magnetic resonance, and laser optics, which virtually revolutionised several branches of science. This era also saw the emergence of biotechnology and the revelution in communication, thanks to the artificial satellites, which led to the explosive growth of information.

Asimov has more than 300 SF novels to his credit. However, *Pebble in the Sky* and *The End of Eternity* are among the best known of his earlier novels. A fact that is not too well known is that these novels were originally written for—and rejected by–some famous SF magazines of the 1940s and 1950s. The novel *Pebble in the Sky* was published in 1950 by Doubleday & Company whose editor then was Walter I. Bradbury.

Asimov had a lot of respect for human values and sentiments. That is why he often raised human problems in his novels. Asimov did not lose this human element while dealing with the solutions to these problems either. This is reflected in the various novels of Asimov including his Foundation novels. Between 1951 and 1953, his three Foundation Novels, christened *The Foundation Trilogy,* were published by Gnome Press. The title Foundation was published in 1951 while the remaining two titles of the Trilogy, viz., *Foundation and Empire* and *Second Foundation* were published respectively in 1952 and1953. Later, Asimov wrote two more Foundation novels. The title *Foundation's Edge* was published in 1982 while *Foundation and Earth* was published in 1986. In these novels, Asimov dealt with the tension and turmoil arising out of intervention between several civilizations of the galaxy, called Galactic Empire. His meticulous handling of the theme in these novels displayed his deep understanding of human nature and social sciences.

Besides his projection of a human angle in his novels, Asimov was endowed with the enviable gift of identifying the core meaning from details. His writings bring out vividly his unfailing ability to pinpoint the irreducible essence of any issue. His popular science writings also speak volumes about this ability of Asimov.

Some of Asimov's books on popular science include titles such as the *Stars and their Courses. The Left Hand of the Electron, The Sun Shines Bright, Counting the Eons and Choice of Catastrophes.* The latter deals with several possible ways in which life on Earth might come to an end. These possibilities include astronomical events like the sun becoming a red giant, moon approaching the Earth due to

the tidal forces, bombardment from the interstellar space, geological factors like weather changes and plate tectonics, as well as man-made disasters like nuclear winter, depletion of resources and irreversible tilting of the ecological balance.

Only a few might be aware that apart from science fiction and popular science writings, Asimov has also written successful detective/mystery stories. Of them mention may be made of a few titles like Tales of the Black Widows, More *Tales of the Black Widows, Casebook of the Black Widows, Authorised Murder and The Union Club Mysteries.*

Asimov was without doubt a prolific writer. He also wrote on many other subjects. He produced a four-volume *History of North America,* a two volume *Guide to the Bible,* a biographical dictionary as well as encyclopedias, text books and two volumes of autobiography.

Asimov won many awards and accolades for his brilliant work. He won four Hugo Awards and a Nebula Award. The Foundation Trilogy was honoured with the Hugo Award.

It is an enjoyable experience to go through the creative works of the genius Asimov. However, as an individual, he was a bit egocentric, often blunt and arrogant. Also, he insisted on traveling by train. It is strange that a genius that described interstellar travel so vividly was himself scared of air-travel. Asimov breathed his last on 6 April, 1992 in New York. He will always be remembered for his laws of roboties.

The Laws of Robotics

The robots are in the service of man in a variety of ways. Besides being used for domestic and industrial purposes, the robots are also being used for handling dangerous and hazardous work and to perform tasks in environments hostile to man. The term 'robot' comes from the Czech word *robota* meaning 'servitide' or 'forced labour'. In fact, the term robot was used for the first time by Karel Capek in his famous play *Rossum's Universal Robots.* In the play it is depicted that the robots turn against their human master. People started fearing the consequences in case robots started harming them or tried to surpass them.

To address these fears and misgivings, Isaac Asimov in one of his SF novels enunciated three laws, now known as Asimov's Laws of Robotics. These laws are:

First Law : A robot may not injure a human being, or through inaction, allow a human being to come to harm.

Second Law : A robot must always obey the orders given to it by human beings except where such orders conflict with the first law.

Third Law : A robot mush project its own existence as long as such protection does not come in conflict with the First and Second laws.

VP news (VIPNET Workshop.....) Contd from page... 36

teaching interesting. Mr. M.V. Kamath, President, Vigyan Prasar and Chairman, Prasar Bharati, gave presidential remarks by explaining observation – experimentation – conclusion as the methodology in science learning.

In the regional workshop, seven sessions were arranged viz. (1) Science in daily life by Dr. Manasi Rajadhyaksha (2) Science Experiments through household waste material by Mr. Abhay Yawalkar MVP (3) Mathematics through Origami by Dr. Sulbha Kashikar (4) Aeromodelling by Mr. Madhav Khare (5) Mathematics made easy by Ms. Shweta Naik and group of Homi Bhabha Centre for Science Education (HBCSE) 6) Sky study by Mr. Suhas Naik Satam of Nehru Planetarium and 7) Ham Radio demonstration by Mumbai Amateur Radio Society.

All the session were backed by either audio-visual lectures, demonstrations cum do it yourselves type experiments. Teachers were very curious about Ham Radio demonstration since they were never exposed to it earlier.

All the participants had a good interaction with faculty of all the sessions, which was a direct indicator of good interest created by various sessions.

Participants visited Nehru Planetarium and saw a sky show and later to Nehru Science Centre. (Report: Marathi Vidnyan Parishad).

A view of the Audience

VP news (Vigyan Rail.....) Contd from page... 36

exhibition. It is estimated that nearly 2,25,000 people visited the exhibition during its halt at Rajkot including students from 300 schools. 18 volunteers explained the exhibits and guided the visitors. 50 Railway Scouts guided and controlled the crowds. Representatives from a few participating Departments/Ministries were also present to help and explain to the visitors. The train departed for Bhopal on 26 June 2004 at 2000 hrs from Rajkot. Vigyan Rail — Science exhibition on wheels was widely covered by the media.

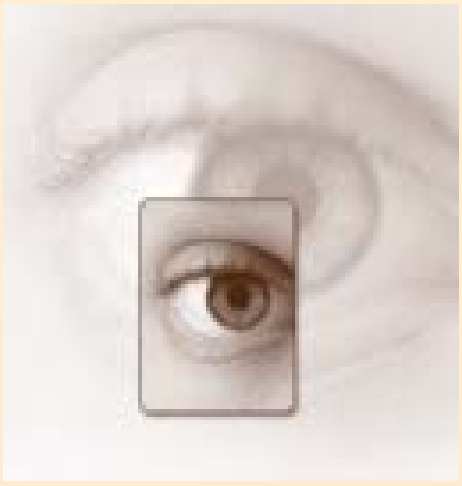
Vigyan Rail at Rajkot: Queues were 1.5 km long as reported in the newspapers

Vision Sense Defective Vision

Looking the Myths in the Eye

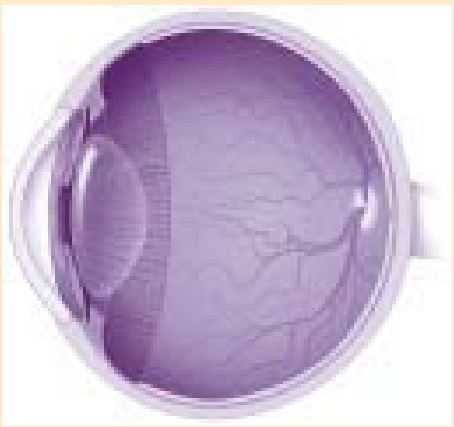
Dr. Yatish Agarwal
e-mail: dryatish@yahoo.com

Of all the special sensory organs that we have been blessed with, the eyes are truly the most precious. A person with normal vision owes over 80 per cent of his knowledge to them. Working in exact unison, our eyes move over a hundred thousand times a day to bring objects into sharp focus. With a wonderful apparatus at work, they effortlessly shift their focus from distant mountains to the 'eye' of a sewing needle, all in a jiffy.



Clever, efficient and hard working as our eyes are, there are times when they are not in perfect order. Errors occur in the optical system of the eye and vision is not at its best. These defects are mainly of four types: shortsightedness (myopia), long-sightedness (hypermetropia), astigmatism (visual axis error) and presbyopia (inability to focus on near objects). These errors are common, yet a large number of skewy myths trail them to clog our minds.

Know that optical error is no disease : Be it any optical error, it neither implies a weak eye nor an eye disease. It is merely a biological variant. Do not treat it as a disease.



Read, read and read : Any amount of reading and minute work you do will never weaken your eyes. The bias is so deep-rooted that some parents even stop their children from reading and enjoying the wonderful world of books. Many elders think that too much reading ruins the child's eyesight and will lead him or her to glasses. That is incorrect. The cause of any optical error lies within the eye: mostly the eyeball is a little too long or too short, or the focussing apparatus is inadequate and faulty.

A myopic child often needs stronger correction lenses as he grows. That is perfectly natural. The eyeballs also elongate as he grows and this worsens myopia. It has nothing to do with the child's reading habit. The growth period ends at eighteen or twenty years and thereafter, myopia gets stabilized.

Eye exercises do not mend optical errors : Many recommend eye exercises to correct longsightedness, shortsightedness and other optical errors. But the truth is that no amount of exercise can change the eye's internal optics. The only good use of eye exercises is in improving the eye movement coordination in people who have a minor degree of squint.

Wear spectacles for correction : Never be fooled into thinking that wearing glasses will weaken or strengthen your eyes. Correction glasses only correct the optical errors when they are worn, but they have no effect, good or bad, on the optical system of the eye. The only difference, and a big one at that, is that glasses help you see better and ease the strain.

Crossed eyes do not make you beautiful or lucky : Crossed eyes are normal in infancy. After the first twelve to eighteen months of life, a child's eye muscles and binocular abilities develop to permit parallel alignment of the eyes. Beyond that age, a cross-eyed child definitely needs a specialist's opinion and treatment.

Yet, strangely, some think that a minor degree of crossed eyes looks beautiful and bring luck, particularly in a girl child. She is thought to be a *Lakshmi* reincarnate! But the neglect inevitably leads to a serious visual disability in the child.

It is equally wrong to think that the child will grow out of it. Neglect it for long and the weaker eye of the child will suffer irreparable loss of vision.

Eating carrots does not improve your eyesight : You can eat carrots by the dozen and be a bunny rabbit, but do not think that it can improve your vision. Vitamin A is necessary for healthy eyes, but it can make no difference to its internal optics of the eye.

Follow the rules of good hygiene: When you consider the evolution of the visual apparatus in man, and the immense increase in the amount and nature of the work which it is called upon to perform in modern civilized life, the wonderful adaptability of the human body makes an amazing story. Yet, we test the resilience of the eyes even further by putting them through hell and fire. Poor illumination, improper source of light, unduly high or low contrast, and reflections and glare expose your eyes to strain. Therefore, if your eyes feel sore and discomforted and pain a bit by the end of the day, mind you: You either need correction glasses or need to improve the illumination conditions at your work place.

Ensure adequate light *:* The human eye can respond

COMMON VISION DEFECTS

Normal Vision : In a normal eye, one that is properly rounded, the image is focused directly onto the surface of the retina and can be seen normally, in perfect focus.

Myopia : In a myopic, or nearsighted eye, the image comes into perfect focus before it reaches the retina. By the time it gets to the retina it is slightly out of focus, producing a blurry image. The situation can be "corrected" with a minus, or concave lens that compensates for the fact that the eye is slightly elongated. The corrective lens, coupled with the eye's own lens system, focuses the image directly on the retina.

Hypermetropia : In a hypermetropic, or farsighted eye, the image reaches the retina before it comes into perfect focus, producing a blurry image. This condition can be "corrected" by using a plus, or convex lens that compensates for the fact that the eye is not long enough. The corrective lens, coupled with the eye's own lens system, focuses the image directly on the retina.

Astigmatism : An astigmatic eye is not properly rounded. As a result, different parts of an image may come into focus before or after it reaches the retina. An astigmatic lens is used to "correct" this situation. This type of lens is made to compensate for the irregular shape of the eye.

Presbyopia : Once people pass the age of forty they start to develop presbyopia. The lens loses its youthful elasticity and its ability to focus on close objects. People with this condition become slightly hyperopic, or farsighted.

Presbyopia can be "corrected" with a plus, or convex lens that would only be required for reading or other close work.

to a very wide range of illumination, from 0.1 lux on a full moon night to 100,000 lux when the sun is shining bright. Yet, despite its versatility to do a job well, it needs an optimum level of illumination. Its sense of form and colour perception is considerably lost in poor light conditions. Visual acuity is at its best when illumination matches the job.

In normal day-to-day activities, the following values of illumination are recommended:

Visual task	Illumination
Casual seeing	100 lux
Lounges	200 lux
Reading	400 lux
Cutting and sewing	600 lux
Bed-head	200 lux
Class rooms	300 lux
Chalk boards	400 lux
Inspection of very small instruments	2,000 lux

Avoid glaring lights : Care should be taken to avoid direct reflection of light into the eyes. Thus, in reading books

printed on shiny paper, if the source of light is in front of the eyes, light is reflected directly into them. This light is useless for visual purposes. It diminishes the contrasts which are the basis of visual discrimination.

The source of light should always be placed on one side and somewhat behind you. If you are a right- handed person, it is best that the light source is located on the left hand side, so that when you are writing, your hand does not cast a shadow.

Work with uniform illumination : The best illumination comes from sunlight. Not only does it provide sufficient intensity, its quality is also unsurpassable. One great advantage is its uniform diffusion. The nearest to this are daylight lamps and fluorescent tubes.

Flickering lights should always be avoided. They can even cause headaches, migraines, and initiate convulsions in those predisposed to epileptic fits.

Avoid too much contrast : The eye works best when the object regarded is surrounded by a field illuminated to the same or slightly less degree. Too much contrast between the areas under observation and surrounding areas causes rapid alterations of adaptation and fatigues the eye. The corollary is never watch the television in a dark room—it strains your eyes.

Eliminate reflections and glares : Glare may be regarded as light in the wrong place. Avoid setting up your worktable in a place which faces glare or reflection from the window and overhead lights.

◆ ◆ ◆

Asafetida (Ferula assa-foetida L.)

T V Venkateswaran
e-mail: tvv123@rediffmail.com

Called Peungayam in Tamil, Asafetida, is also known as Heingh in Hindi. Actually asafetida is the milk juice (Oleo-gum resin) from living rhizomes and roots of the plant F. assa-foetida. The milk, after drying becomes a brown, resin-like mass. The plant belongs to Apiaceae (parsley family) and has very strong smell, rather repugnant, remotely similar to garlic. Acrid in taste, it emits a strong onion like odour because of its organic sulfur compounds. Although not native to India, it has been used in Indian medicine and cookery for ages. It was believed that asafoetida enhanced singers voices. In the days of the Mughal aristocracy, the court singers of Agra and Delhi would eat a spoonful of asafoetida with butter and practice on the banks of the river Yamuna.

Main constituents

Asafoetida is a hard resinous gum, grayish-white when fresh, darkening with age to yellow, red and eventually brown. The greater part of asafoetida consists of a gum (20 to 30 per cent.) and resin (50 to 70 per cent.). These, with the volatile oil (3 to 9 per cent.), form with water a milky emulsion. The resin is ferulic ester of asaresino-tannol, $C_{24}H_{35}O_5$, which, by sublimation, yields umbelliferone. There is also contained in the drug vanillin 0.06 per cent., ferulic acid, $C_{10}H_{10}O_4$, 1.28 per cent. The resin, when fused with KOH, yields resorcin and protocatechuic acid. Dried asafetida consists mostly of a resin (25 to 60% of the total mass, 60% of which are esters of ferula acid) and a complex carbon hydrate part (25 to 30%). It is sold in blocks or pieces as a gum and more frequently as a fine yellow powder, sometimes crystalline or granulated.

The essential oil (10%) contains a wealth of sulfur compounds, mainly (R)-2-butyl-1-propenyl disulphide (50%), 1-(1-methylthiopropyl) 1-propenyl disulphide and 2-butyl-3-methylthioallyl disulphide. Furthermore, di-2-butyl trisulphide, 2-butyl methyl trisulphide, di-2-butyl disulphide and even di-2-butyl tetrasulphide have been found. The essential oil contains also some terpenes (á-pinene, phellandrenen) and hendecylsulphonyl acetic acid. Ethers of sesquiterpenes with coumarines have also been identified (farnesiferoles).

The name Game

Actually the species name assa-foetida is made up of elements from two languages: *Assa* is a Latinized form of Farsi *aza* - "resin", and Latin *foetidus* means "smelling, fetid". The odd putrid smell of fresh asafetida indeed justifies the name "devil's dung". German Teufelsdreck, French merde du diable, Swedish dyvelsträck and Turkish ºeytan tersi all are very picturesque names; all meaning more or less politely "dung of devil", exemplify the small enthusiasm this unusual spice meets outside the regions of its traditional usage.

Various species of genus Ferula grow wild from the Eastern Mediterranean to Central Asia. Most important as spice is F. assa-foetida.A related species (*F.vulgaris*), of Asafetida (Ferula assa-foetida L.), native to the Mediterranean, is mentioned in the Greek mythology as the plant that helped Prometheus to carry the stolen fire from the Sun to the Earth. It has been suggested that stone-age nomad tribes might have indeed used the hollow stems to transport fire between their camps

Legend has is that Asafetida was encountered by the soldiers of Alexander the Great on their march through Central Asia. The conquests of Alexander opened trade routes that made Eastern commodities available in the Mediterranean region, and like black pepper, asafetida established itself quickly on the new market. It was used in ancient Greek and Roman cuisines, often as a substitute for the expensive North African silphion. After the latter's extinction, asafetida became even more common, and continued to be used though the early Middle Ages (for example, to flavour barbecued mutton in France). Later, however, its popularity ceased: After the 16th century, it is no more mentioned in European cookbooks.

As an food ingredient

In central Asia the whole plant is used as a fresh vegetable, the inner portion of the full-grown stem being regarded as a delicacy. The horrible smell of fresh asafoetida does not seem to qualify as a valuable food enhancement, but after frying (and in small dosage), the taste becomes rather pleasant, even for Western taste buds. The so-called "powdered asafetida" is the resin mixed with rice flour and therefore much less strong in taste, but more easy in application.

Usage of asafetida differs a little bit for the powdered form and the pure resin. The resin is *very* strongly scented and must be used with care; furthermore, it is absolutely necessary to fry the resin shortly in hot oil. This has two reasons: First, the resin dissolves in the hot fat and gets

better dispersed in the food, and second, the high temperature changes the taste to a more pleasant impression. A pea-sized amount is considered a large amount, sufficient to flavour a large pot of food. Powdered asafetida, on the other hand, is less intense and may be added without frying, although then the aroma develops less deeply. Lastly, powdered asafetida loses its aroma after some years, but the resin seems to be remain strong more than ten years. Careful dosage is, though, essential; in ancient Rome, asafetida was stored in jars together with pine nuts, which were alone used to flavour delicate dishes. Another method is dissolving asafetida in hot oil and adding the oil drop by drop to the food.

In Central Asia and India, asafetida has remained as an important culinary spice and also herbal medicine to this day. It is much used in Persian cooking, and especially popular in India. In some parts of our country, the Brahmins refuse to eat onions and garlic and often use asafetida instead. In the South India, asafetida is even more popular. The Tamil (South Indian) spice mixture *sambaar podi* contains asafetida. Although exceptions exist, asafetida has the reputation of being a spice for vegetables, not meats in Indian culinary.

Asafetida is a good example for the overlapping of culinary and medicinal use of a plant. Particularly in South India, asafetida is almost canonical for the preparation of legumes (beans, peas, lentiles). Dal (or its various south Indian variety Rasam or Sambar) is a chief element of the Indian vegetarian diet, as it is not only a cheap source of protein, but also one of the few protein sources open to vegetarians. Moreover, dried legumes are easy to store and have a long shelf life. However, being rich in indigestible oligosaccharids, they call for spices with prominent antiflatulence action. Asafetida, garlic and cumin are commonly used to make dal both more tasty and less cumbersome.

The Plant

The plant is a perennial of the carrot family and may grow as high as 3.6m. After four years, when it is ready to yield asafetida, the stems are cut down close to the root, and a milky juice flows out that quickly sets into a solid resinous mass. A freshly exposed surface of asafetida has a translucent, pearly white appearance, but it soon darkens in the air, becoming first pink and finally reddish brown.

A coarse umbelliferous plant growing up to 25 meters high, large fleshy root covered with bristly fibres. The stem grows upto 18-30 meters and contains numerous stem leaves with wide sheathing petioles. The flowers are pale greeny yellow and the fruit is oval in shape, flat thin, foliaceous, reddish brown with pronounced vittae. It has a milky juice and a strong foetid odour. Several species of *Ferula* yield Asafetida.

The bulk of the Asafetida harvest comes from the official plant, which is indigenous to Afghanistan and grows from two to four thousand feet above sealevel. These high plains are arid in winter but are thickly covered in summer with a luxuriant growth of these plants. The great cabbage-like folded heads are eaten raw by the natives. June is the month the juice is collected from plants about four years old. The roots of plants which have not flowered are exposed and slashed, then shaded from the sun for five or six weeks and left for the gummy oleoresin to leak out and harden. It is then scraped off in reddish lumps and put into leather bags and sent to Herat, where it is adulterated before being placed on the market. The fruit is sent to India for medicinal use. A very fine variety of Asafetida is obtained from the leaf bud in the centre of the root is only used in India, where it is known in the Bazaars as Kandaharre Hing. It appears in reddish-yellow flakes and when squeezed gives out an oil.

To make the drug asafetida, in March and April, just before flowering, the stalks are cut close to the root. A milky liquid oozes out, which dries to form a resin. This is collected and a fresh cut is made. The gum is scraped off the root and preserved for sale. This procedure lasts for about three months from the first incision, by which time the plant has yielded up to two pounds of resin and the root has dried up.

Attributed medicinal properties

When harvested, the resin is composed of white tears of various shapes and sizes, imbedded in a brown, sticky mass, along with vegetable trash and earthy impurities. These masses are at first soft, but harden on exposure, the tears breaking with a conchoidal fracture, at first milk-white, but gradually turning pink, and at last brown. It resembles galbanum very much in appearance, but is easily. distinguished by its *strong, disagreeable, alliaceous odor*, due to a sulphuretted volatile oil present to the extent of 3 to 9 per cent. On adding ammonia to a decoction of the sublimated resin, a blue fluorescence is exhibited. Taste acrid, bitter, and alliaceous. When assayed by the official process asafoetida should contain not less than 60 per cent. of alcohol soluble constituents.

Asafoetida is known as an antidote for flatulence and is also prescribed for respiratory conditions like asthma, bronchitis and whooping cough. Its vile smell has led to many unusual medical claims, mostly stemming from the belief that it's fetid odor would act as a deterrent to germs.

In several European countries a small piece of the resin would be tied on a string and hung around childrens' necks to protect from disease. The shock of the sulfurous smell was once thought to calm hysteria and was included in a mixture with other strong spices as a cure for alcoholism.

The odour of Asafetida is stronger and more tenacious than that of the onion, the taste is bitter and acrid; the odour of the gum resin depends on the volatile oil. It is a local stimulant to the mucous membrane, especially to the alimentary tract, and therefore is a remedy of great value as a carminative in flatulent colic and a useful addition to laxative medicine. There is evidence that the volatile oil is eliminated through the lungs, therefore it is excellent for asthma bronchitis, whooping-cough, etc. Owing to its vile taste it is usually taken in pill form, but is often given to infants per rectum in the form of an emulsion. The powdered gum resin is not advocated as a medicine, the volatile oil being quickly dissipated. ◆ ◆ ◆

Recent Developments in Science and Technology

Milky Way's 'Satellite Problem' Solved

Our Milky Way galaxy is surrounded by several smaller orbiting galaxies . The size of this cosmic neighborhood has perplexed astrophysicists for some time because the currently favored theory of galaxy formation predicts 10 times as many satellites. But new computer simulations run by Andrey Kravtsov of the University of Chicago and his colleagues have shown that the relative paucity of Milky Way companions may not be such a concern after all. Standard cosmology says that most of the matter in the universe is an unknown substance that moves slowly and does not emit light. Over time, small clumps of this cold dark matter have merged to form increasingly large clumps. Above a certain mass threshold, normal matter inside these dark matter objects, called halos, forms stars, and eventually galaxies. Computer models incorporating this hierarchical progression have successfully reproduced the cosmic web that astronomers can see in their largest maps of the heavens. But it has been hard to accurately simulate individual galaxies and their vicinities because there are more details to worry about at these smaller scales. The new simulations, published in *The Astrophysical Journal,* probed the formation history of a Milky Way-type environment using relatively small time increments, which allowed the researchers to follow the ebb and flow of the dark matter.

Source :Scientific American, June 2004

Hybrid nano-wires provide link to silicon

Nanoscale electronic components that could be plugged into conventional computer circuits have been developed for the first time by US chemists. Nanoscopic electronic wires have already been made in the laboratory, often using exotic materials such as carbon nanotubes. However, to be of practical use, such components will need to be connected to larger electronic components. And existing electronics are usually made with silicon, which cannot easily be connected to nanotubes.

But now, Charles Lieber and colleagues at Harvard University in Cambridge, Massachusetts, have developed highly conductive nanowires by blending silicon and nickel together. These could provide a way to connect nanoscale components with existing electronic components, which are hundreds or thousands of times larger.

A huge amount of research is being done on nanoscale electronics, because such miniaturization would enable computer makers to pack in far more processing power.

Source : New Scientist, June 2004

Astronomers Discover Youngest Planet Yet

NASA's newest observatory, the Spitzer Space Telescope, has found evidence of the youngest planet yet detected. These results will expand our understanding of how stars and planets form, which ultimately helps us understand our origins.

Launched in August 2003, Spitzer surveys its galactic surroundings using instruments that detect infrared radiation. The telescope recently observed a star located some 420 light-years away and found a clearing in the dusty disk surrounding it, which could be caused by a planet gathering material as it forms—like a broom sweeping across a dirty floor. This potential planet is less than a million years old. The additional details that Spitzer can offer about planet-forming disks should provide scientists with a better understanding of how solar systems like ours evolve.

Source : Scientific American .com

Complied by : Kapil Tripathi

Two Centenaries... *contd from page... 35*

More recently, in 1999, he was awarded the Ewald Prize by the International Union of Crystallography. Ironically these honours came to Ramachandran late in his life, long after he had made his seminal contributions. He was a lover of classical music and the game of cricket. There is no gainsaying the fact that Ramachandran was undoubtedly one of the greatest scientists independent India has ever seen. However, it is rather sad, not many in our country are aware of this genius, nor his contributions. He died on 07 April, 2001 at Chennai.

To make people aware of Ramachandran's monumental work, and help our youth derive inspiration from his illustrious life, Institute for Genomics and Integrative Biology (IGIB) at Delhi headed by Dr. Samir Brahmachari – a student and a colleague of Ramachandran - has taken the lead to celebrate the Golden Jubilee of the discovery of the Triple Helix of collagen molecule, reported in *Nature* on 07 August, 1954. Vigyan Prasar also is a partner with IGIB. Indeed, it is imperative that we make our children aware of the great contributions made by Jamsetji, JRD, and G. N. Ramachandran; and the values they cherished through a variety of programmes, means and modes during this special year with two centenaries and a Golden Jubilee. This would be the best tribute to these great personalities of our country.

❐ V. B. Kamble