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Monthly Newsletter of Vigyan Prasar

# DREAM 2047

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## VP News

## Presentation on Vigyan Rail in Cambodia

Dr. V.B. Kamble, Director, Vigyan Prasar, visited Cambodia to participate in a meeting of South-East and East Asian Countries, on Distance Learning Technologies, organized by International Development Research Centre (IDRC), Canada. IDRC is a multi-national organization which helps generate and support developmental programmes in different countries of the world for converting their ample human resources into human capital for improving their socio-economic status. IDRC is working towards the goal of providing quality tertiary education that is accessible and affordable for the masses through the deployment of appropriate emerging distance learning technologies (DLTs).


*Dr. V.B. Kamble, Director, Vigyan Prasar, Dr. Zeba Khan and Prof. Santosh Panda – the Indian delegation at the Cambodia Meet on emerging Distance Learning Technologies*

The meeting was held at Siem Reap during the period 20-25 September, 2004, where the famous Angkor Wat Temple of Lord Vishnu is situated. The purpose of the meeting was to evolve relevant proposals on Distance Learning Technologies for South-Asian and South-East Asian Countries to be supported by IDRC. Dr. Kamble was especially invited to make a presentation on Vigyan Rail as an access model for science and technology communication, which could be complementary to the access models like radio, television, internet, open universities, etc. The presentation was received very well and evoked a lot of interest as regards the concept of taking science to the people through the medium of an exhibition train. Participants from Canada and Pakistan appeared especially interested in the Vigyan Rail. Dr. Kamble also was instrumental in developing a proposal entitled "Accessibility, Acceptance and Effects of Distance Learning Technologies in South Asia", along with Professor Santosh Panda and Dr. Zeba Khan - both from Indira Gandhi National Open University, New Delhi, and Dr. Nazir Ahmed Sangi, Allama Iqbal Open University, Islamabad, Pakistan, and Prof. V.K. Samaranayake, University of Colombo, School of Computing, Sri Lanka.

## Inside



## Vigyan Prasar's Participation at the SAARC BOOK Fair at Colombo

Vigyan Prasar participated at the Third SAARC Book Fair at Colombo, Sri Lanka, (September 06-12, 2004). Dr. Subodh Mahanti, Scientist "F" and Shri V. K. Joshi, Registrar represented Vigyan Prasar at the Fair. Earlier Vigyan Prasar had attended the First SAARC Book Fair held at Dhaka, Bangladesh (September 26-29, 2002). The purpose of participating at the SAARC Book Fairs was for promotional activity—to explore what kind of possibilities exist for promoting Vigyan Prasar's software in the SAARC countries, to be familiarized with popular S&T software produced in these countries and develop

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Editor : Dr. V.B. Kamble

# A Satellite for Education, Science And Technology

It was in 1975-1976 that beaming educational programmes through satellites was successfully demonstrated for the first time by India. Famous in the history of Distance Learning Technology as the Satellite Instructional Television Experiment (SITE), it was conducted using the American Applications Technology Satellite (ATS-6). Indeed, this was a unique experiment which was hailed as the largest sociological experiment conducted anywhere in the world. Programmes related to health, hygiene and family planning were telecast directly to about 2400 Indian villages spread over six States and 45,000 teachers trained. To receive the programmes, television sets with direct reception facility were provided in the community centres of these villages. Ever since the advent of INSAT system in 1983, a variety of educational programmes are being regularly telecast. Yet another landmark was the Jhabua Developmental Communication Project in Madhya Pradesh and the Training and Developmental Communication Channel – both conceptualized and executed by the Development and Educational Communication Unit (DECU) of ISRO - that further demonstrated the utility and efficacy of satellite technology for education.

It was with the success and efficacy of the INSAT series of satellites for educational services that ISRO conceived the EDUSAT project – a satellite for education – in October 2002. EDUSAT was successfully launched on 20 September, 2004 from the Satish Dhawan Space Centre at Sriharikota using India's own Geosynchronous Satellite Launch Vehicle (GSLV) making it the first exclusive satellite for serving the educational sector. EDUSAT would provide an interactive satellite based distance education system for the country utilizing audiovisual medium, and employ Direct To Home (DTH) quality broadcast. It is important to note that EDUSAT will have multiple regional beams covering different parts of India - five Ku band transponders with spot beams covering Northern, North-Eastern, Eastern, Southern, and Western regions of the country, a Ku band transponder with its footprint covering the Indian mainland region and six C band transponders with their footprints covering the entire country. Incidentally, transponders are electronic devices that receive, amplify and re-transmit electromagnetic signals sent from ground stations. This is how a programme is beamed to and from satellites.

There is no gainsaying the fact that education is an instrument of social change. Literacy and universalisation of education remain the top priority both in India and other developing countries. In India, the problem is compounded by the fact that we have several language groups with diverse cultures separated by vast geographical distances. As a result, imparting quality education to remote and rural areas becomes a mammoth challenge. Further, the lack of adequate rural educational infrastructure and non-availability of good teachers in sufficient numbers further aggravates the problem. It is here that satellites can play a vital role by establishing connectivity between urban educational institutions that have adequate infrastructure to impart quality education, and the large number of rural and semi-urban educational institutions that lack the necessary infrastructure. A single teacher can simultaneously teach thousands of students in different schools / colleges across the country. From a television studio, the teacher can explain a topic, and in colleges with reception facilities, students can see and listen to him. If they have interactive facilities, the students can also put questions and get the answers. One advantage EDUSAT has is it has regional beams. Hence teachers can conduct classes in regional languages.

Surely, EDUSAT is meant for providing connectivity to school, college and higher levels of education and also to support non-formal education including developmental communication. Once commissioned, the first two years of EDUSAT will mark the semi-operational phase in which it is estimated that programmes from EDUSAT can reach 1,000 classrooms and 50,000 students. It is expected that these numbers would rise manifold as institutions gain familiarity and confidence, and the technology spreads and finds new users. Content generation, however, would be the responsibility of the user agencies. Needless to say, the quantity and quality of the content would ultimately decide the success of EDUSAT System. When EDUSAT network becomes fully operational, ISRO will provide technical and managerial support in the replication of EDUSAT ground systems to manufacturers and service providers.

One of the EDUSAT channels on the beam covering the entire country will be exclusively for Science and Technology communication, for initiating a Science Channel for India called "Jigyasa". Hence, EDUSAT would in effect stand for a satellite for **Edu**cation, **S**cience, **A**nd

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**Editor** : **V.B. Kamble**

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# Julius Robert Oppenheimer

## A Great Synthesiser of Ideas

❑ Subodh Mahanti
e-mail: mahantisubodh @ yahoo.com

"Dr. Oppenheimer, I am pleased that you are here today to receive formal recognition for your many contributions to theoretical physics and to the advancement of science in our nation. Your leadership in the development of an outstanding school of theoretical physics in the United States and your contributions to our basic knowledge make your achievements unique in the scientific world."

*President Lyndon Johnson while the presenting the US Atomic Energy Commission's Enrico Fermi Award to Robert Oppenheimer on December 02, 1963.*

"Any single one of the following contributions would have marked Oppenheimer out as a pre-eminent scientist: his own research work in physics; his influence as a teacher; his leadership at Los Alamos; the growth of the Institute for Advanced Study to a leading centre of theoretical physics under his directorship; and his efforts to promote a more common understanding of science. When all combined, we honour Oppenheimer as a great leader of science in our time. When all is interwoven with dramatic events that centred around him, we remember Oppenheimer as one of the most remarkable personalities of this century."

*Abraham Pais*

"It is not possible to be a scientist unless you believe that knowledge of the world, and the power which this gives, is a thing which is of intrinsic value to humanity, and that you are using it to help in the spread of knowledge, and are willing to take the consequences."

*Robert Oppenheimer*

Julius Robert Oppenheimer was a first class theoretical physicist, a synthesiser of ideas, an inspiring teacher, an able scientific administrator, a nuclear policy-maker and an advocate of international arm control. However, Oppenheimer is mainly remembered for his association with the Manhattan Project. This project spearheaded by Oppenheimer led to the development of the atomic bomb. This was one of the most controversial scientific enterprises of the 20th century. The story of Oppenheimer or the story of how the atomic weapon was made, is really gripping. Oppenheimer was one of the most brilliant men of the twentieth century. Thus his longtime associate Charles Lauritsen said: "This man was unbelievable. He always gave you the answer before you had the time to formulate the question." He was one of the most inspiring teachers of his time. The story of Oppenheimer's life and work make a compelling reading. It is compelling not only because he headed a project that unleashed a terrifying power that changed the world for ever but it also clearly demonstrated what dominating role science would play in the world affairs.

*Robert Oppenheimer*

Oppenheimer was born on April 22, 1904 to a wealthy family in New York. In those days New York was the scientific and commercial capital of the USA. His father Julius Oppenheimer had come to the USA from Germany at the age of 17 in 1888. At the time of his arrival, Julius had no fortune. He possessed few job skills and he could speak little English. However, he prospered in his adopted country as a successful garment importer. To make a career, Julius was helped by his other family members, who were already in the USA. Two of his older cousins had come to New York about 10 years before Julius' arrival. Julius Oppenheimer was quite active in many community affairs. He was interested in art and music. In his collection of paintings he had three Van Gogh's. Oppenheimer's mother, Ella Oppenheimer (nee Freedman) was a painter, who had studied in Paris. Oppenheimer attended the New York School for Ethical Culture. It is in this school Oppenheimer spent almost the whole period of his pre-college studies. The school, run by Felix Adler, a philosopher and an educator, was one of the best schools in New York. At all levels, the school curriculum stressed the responsibility of the individual to the larger society. In school he was taught language, literature including Greek and French literature, science, art and ethics. He had a true feel for language. He could learn a new language in a

period of one or two months. He learnt Sanskrit. He had developed a keen interest in literature. He had even written some philosophical poems.

Oppenheimer's interest in science developed very early. Since his childhood he was always eager to explore the nature around him and to understand its different phenomena. Already at the age of five, Oppenheimer collected mineralogical specimens. It was his grandfather who made him interested in mineralogy. One of his biographers, Jack Rummel, wrote: "When he was five, his parents took him and his brother Frank back to Germany to visit his grandfather, Benjamin, who had remained in Europe after Julius Oppenheimer immigrated to the United States. His grandfather gave Robert a gift of a collection of minerals. The chiseled and glittering stones immediately captivated the boy. After he returned to the United States, he became a devoted amateur mineralogist, often touring the countryside during weekends in search of new samples to add to his collection. His fascination with geology and mineralogy became so strong that by his 11th birthday he had become an elected member of the New York Mineralogical Club. His first scientific paper was a report about minerals that he read to the club when he was 12."

*Julius Oppenheimer holding his son Robert, about 1906 (courtsey: J. Robrt Oppenheimer Memorial Committee)*

After completing his school education in 1922, Oppenheimer joined the Harvard University. In 1925 he graduated with a major in chemistry. He took just three years for the normal four-year course. In addition to studying the science subjects he learnt Latin and Greek. At Harvard he was very much influenced by Percy Williams Bridgman (1882-1961), an original experimental physicist. It was Bridgman, who attracted Oppenheimer to the world of physics. In Oppenheimer's own words Bridgman was "wonderful teacher because he never really was quite reconciled to things being the way they were and he always thought them out; his exercises were a good way to learn where the bones were in ...physics...He was a man to whom one wanted to appreciate." At Harvard Oppenheimer did not miss any chance to gain knowledge. Later he said: "I had a real chance to learn. I loved it. I almost came alive. I took more courses than I was supposed to, lived in the library stacks, just raided the place intellectually."

*Percy Williams Bridgman*

In the last year of his graduation, Oppenheimer had made up his mind to plunge into the world of physics. The decision was not easy. He knew that his degree majoring in chemistry would not be welcomed by the renowned physicists at the leading European universities, with whom Oppenheimer would like to work for his graduate study in physics. He also knew that he had only a beginner's knowledge in physics. With a letter of recommendation from Percy Bridgman, Oppenheimer left USA for England in September 1925. This was the beginning of his four-year tour to the great centres of physics in Europe. The year 1925, in which Oppenheimer decided to enter physics, was very important in the history of physics. In this year the modern quantum mechanics came into being. He spent the year 1925-26 at the Cavendish Laboratory of the Cambridge University, where he came in contact with Lord Ernest Rutherford (1871-1937), one of the finest research physicists of the twentieth century. Initially Rutherford was not very willing to admit Oppenheimer as a student at the Cavendish Laboratory. However, relentless pleading for admittance by Oppenheimer persuaded Rutherford to change his mind. Oppenheimer was placed under the charge of Joseph John Thomson (1856-1940), who had discovered electron in 1897.

The stay at Cambridge was not much enjoyable for Oppenheimer. He had to consult a psychiatrist for treatment for his emotional problems. He did not like the work at Thomson's laboratory. He wrote to one of his Harvard friends, Francis Fergusson: "I am having a pretty bad time. The lab work is a terrible bore, and I am so bad at it that it is impossible to feel that I am learning anything." At Cambridge he read physics with all seriousness. He became familiar with the new ideas in physics. He mastered quantum mechanics. At Cavendish Laboratory Oppenheimer also met Niels Bohr, who had come there to meet his old teacher Rutherford. Oppenheimer realized that his aptitude was more suited to theoretical physics and not experimental physics. Eventually he overcame his emotional insecurities.

After completing one year at Cambridge he went to Germany to work with the German-born British theoretical physicist Max Born (1882-1970) at the University of Gottingen for his PhD. He completed his PhD within two years after his graduation. With Born, Oppenheimer wrote a very important paper on the "Quantum Theory of Molecules." After obtaining his PhD in 1927, he returned to the USA for the academic year 1927-28 and became a Fellow of the National Research Council, first at Harvard University and then at the California Institute of Technology. As a Fellow of the International Education Board (1928-29), Oppenheimer visited Leiden and Zurich. During this period he worked with the Austrian-born American physicist Wolfgang Pauli (1900-58), who

influenced his scientific work to a great extent. During his stay at Europe, Oppenheimer also interacted with the German physicist Werner Heisenberg (1901-76), and the Italian-born American physicist Enrico Fermi (1901-54). Heisenberg formulated the principle of nuclear indeterminancy and he was awarded Nobel Prize in physics in 1932. It was Fermi who directed the construction of the first atomic pile. Fermi was awarded the Nobel Prize in physics in 1938.

Commenting on the work done by Oppenheimer during his stay at Europe, Rummel wrote: "Between 1926 and 1929, his last year in Europe, Oppenheimer published 16 papers on the physics of quantum mechanics. His papers, which were densely mathematical and difficult for a non-physicist to understand, used the concept of quantum theory to focus on different aspects of the atom, such as electron spin, or the idea that the electron itself spins on its own axis as it moves around the nucleus in the same way the Earth spins as it moves around the Sun. The concept of electron spin helped physicists resolve questions about how the atom binds together." The sixteen papers published by Oppenheimer marked him as a rising theoretical physicist.

*Max Born*

After returning from Europe, Oppenheimer accepted joint appointments at the California Institute of Technology at Pasadena and the University of California at Berkeley. The areas in which he worked included quantum electrodynamics, cosmic rays, nuclear physics and astrophysics including the first theoretical suggestion of black holes. It was at Berkeley, that Oppenheimer created his great school of theoretical physics. Most of the best theoretical physicists who grew up in 1930s or 1940s were trained by Oppenheimer at one stage or other. Hans Albert Bethe (1906- ), who worked with Oppenheimer at Los Alamos, wrote: "...Oppenheimer created the greatest school of theoretical physics that the United States has ever known. Before him, theoretical physics in America was a fairly modest enterprise, although there were a few representatives. Probably the most important ingredient he brought to his teaching was his exquisite taste. He always knew what were the important problems, as shown by his choice of subjects. He truly lived with these problems, struggling for a solution, and he communicated his concern to his group. In its heyday, there were about eight or ten graduate students in his group and about six Post-doctoral Fellows. He met this group once a day in his office, and discussed with one another the status of the student's research problem. He was interested in everything, and in one afternoon they might discuss quantum electrodynamics, cosmic rays, electron pair production and nuclear physics."

In California, Oppenheimer actively participated in radical politics. Besides joining the radical Teachers' Union, Oppenheimer was associated with a number of other organizations secretly controlled by Communist Party activists. To quote Oppenheimer: "I became a real left-winger...joined the teachers' Union, had lots of Communist friends. It was what most people do in college or late high school...but I'm not ashamed of it. I'm more ashamed of its lateness. Most of what I believed then, now seems complete nonsense, but it was an essential part of becoming a whole man." It is not known whether Oppenheimer was actually a Communist Party member or not. However, his association with left politics became major concerns for the authorities when Oppenheimer was working at Los Alamos for developing the atomic weapon.

*Hans Albert Bethe*

In May 1942 General Leslie R. Groves appointed Oppenheimer as Director of the Central Laboratory for Bomb Design and Development in Los Alamos, New Mexico. This was the beginning of the Manhattan Project, which led to the development of the atomic bomb. The choice of Oppenheimer was rather surprising. He was not a Nobel Laureate and so his stature was not equal to those of some others who would be expected to join the group. Oppenheimer was a theorist but he was expected to lead a largely experimental programme. The Manhattan Project was work of massive scale and significance. He succeeded in gathering a group of gifted scientists and generating an atmosphere of urgency. He skillfully handled the interface between his military superior General Groves and the unorthodox research scientists under him.

It was a very difficult task. They had only some theoretical ideas about how to proceed. Victor Weisskopf, a colleague of Oppenheimer at Los Alamos, said: "The task facing Oppenheimer and his collaborators was stupendous. When the work started at Los Alamos not much more was known than the fundamental ideas of a chain reaction. What happens in a nuclear explosion had to be theoretically predicted in all details for the design of the bomb since there was no time to wait for experiments; no fashionable material was available yet. The details of the fission process had to be understood. The slowing down of neutrons in matter and the theory of explosions and implosions under completely novel conditions had to be investigated. Nuclear physicists had to become experts in fields of technology unknown to them such as shock waves and hydrodynamics. Oppenheimer directed these studies,

theoretical and experimental, in the real sense of the words. Here his uncanny speed in grasping the main points of any subject was a decisive factor; he could acquaint himself with the essential details of every part of the work.

*Isacc Isador Rabi*

He did not direct from head office. He was intellectually and even physically present at each decisive step. He was present in the laboratory or in seminar rooms, when a new effect was measured, when a new idea was conceived. It was not that he contributed so many ideas or suggestions; he did so sometimes, but his main influence came from something else. It was his continuous and intense presence, which produced a sense of direct participation in all of us; it created that unique atmosphere of enthusiasm and challenge that pervaded the place throughout its time."

It was Oppenheimer's intelligence, his unique capacity for assimilating different ideas and his administrative and leadership qualities which made the Manhattan Project successful. Edward Teller, who worked with Oppenheimer and who later worked for the development of the hydrogen bomb, wrote: "Oppie (Oppenheimer) knew in detail what was going in every part of the laboratory. He was incredibly quick and perceptive in analyzing human as well as technical problems…Oppie knew [what the staff's] relationships with one another were and what made them tick. He knew how to organize, cazole, humor, soothe feelings—how to lead powerfully without seeming to do so. He was an exemplar of dedication, a hero who never lost his humanness. Disappointing him somehow carried with it a sense of wrongdoing."

After four years' of hard work the team headed by Oppenheimer at Los Alamos designed and built two types of atomic bombs. The first type was a uranium bomb that was triggered by U-235 "bullet" that was impelled into a U-235 sphere by an explosive. It was called 'Little Boy". The other was a plutonium implosion-type bomb consisting of a plutonium core, surrounded by an initiator of polonium and beryllium and a circle of explosive. This type was called "Fat Man". By July 1945, four bombs were built—two bombs of plutonium-assembly type, one bomb for test and another for keeping in reserve, two bombs, one of each type, for possible use.

Oppenheimer named the site for the first-ever site for atomic explosion Trinity after a sonnet by the English poet John Donne. This is because Oppenheimer thought Donne's sonnet set the proper tone for the experiment at Trinity. The test of the first atomic bomb called the Fat Man at the Trinity Site on July 16, 1945 was a step into the unknown. No one including the scientist who actually built the bomb knew exactly what would happen when the bomb exploded. The test, though there were several hours of delays because of bad weather and dangerous winds, went exactly as planned. Finally the first atomic bomb exploded over the desert. It changed the world for ever. Enrico Fermi who viewed the explosion from an elevated desert floor called Compania Hill, thirty kilometres away from the actual site said: " Although I did not look directly toward the object. I had the impression that suddenly the countryside became brighter than in full daylight…After a few seconds the rising flames lost their brightness and appeared as a huge mushroom that rose rapidly beyond the clouds."

*Victor Weisskopf*

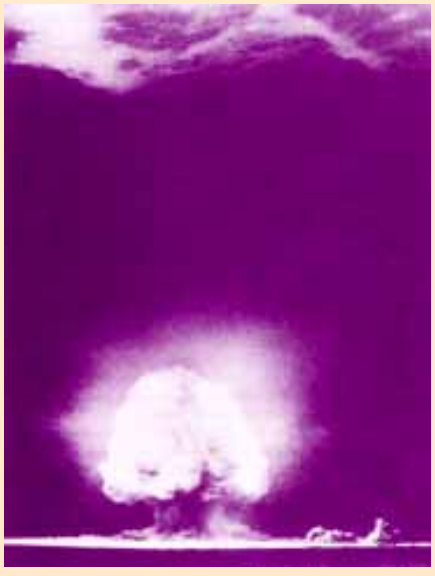
After seeing the all-illuminating flash of the explosion of the atomic weapon, Oppenheimer recited a Sanskrit verse from the *Bhagvad Gita.*

"If the radiance of a thousand suns
Were to burst at once into the sky,
That would be like the splendor of the Mighty One.

**********

I am become Death
The destroyer of worlds.

Oppenheimer, like any other scientist associated with the project, was elated at the success of the project. They were working with a patriotic zeal to ensure the defeat of Germany and its allies, to wipe out war for ever from the face of the Earth. However, Oppenheimer was deeply concerned with the ominous implications of the atomic weapon. At Los Alamos, Oppenheimer had discussed his concerns with Niels Bohr. In his later life Oppenheimer was a strong advocate of the international control of the atomic weapon.



*Detonation of the first atomic weapon, Trinity Site, July 1945 (Courtsey: Los Alamos Laboratory).*

At the time of acquiring atomic weapons the Second World War was not yet over. Japanese forces continued to fight bloody battles. It has been reported that Japan was given an warning to surrender or face inevitable complete destruction of Japanese armed forces and the utter devastation of Japanese homeland. Japan ignored the warning and resolved to fight for successful conclusion of the war. The

first atomic weapon was dropped on Hiroshima on August 06, 1945. The bomb was "Little Boy" type and the aircraft, which carried the bomb was called *Enola Gay*. The destruction was complete. One member of the crew of *Enola Gay* later recalled: "I don't believe anyone ever expected to look at a sight quite like that. Where we had seen a clear city two minutes before, we could no longer see the city." Japanese did not surrender. So on August 09, 1945 another atomic bomb, the "Fat Man" type was dropped on the southern city of Nagasaki. On August 14, 1945, Emperor Hirohito (1901-89) announced Japan's surrender. The terms of the surrender were signed on September 02, 1945 aboard the battleship USS Missouri and the Second World War was ended officially.

*Enrico Fermi*

Oppenheimer served as the Chairman of the Atomic Energy Commission's General Advisory Committee. It was very important and time-consuming responsibility. The Committee included Fermi, Rabi, Conant, Dubridge, Smythe and Seaborg and two industrialists, Worthington and Rowe. The Committee used to have six sessions a year. It advised the Commission on both scientific matters as well as matters of general policy. Seaborg wrote: "At the conclusion of each session, when the AEC Commissioners came in to review our work, Oppie presented a masterful summary of the proceedings. I know that my fellow members of the GAC remember with me that this was pure Oppenheimer at his very best. I regret that tape-recordings were not made of these eloquent summations of our deliberations, for I believe that these would provide fascinating historical material." As a Chairman of the General Advisory Committee of the Atomic Energy Commission, Oppenheimer played an important role in strengthening and expanding research in physics particularly in nuclear physics. Oppenheimer led the General Advisory Committee's opposition to the development of the hydrogen bomb. The opposition to the hydrogen bomb was not entirely on moral ground but also because fusion did not appear technically feasible. Further the Committee thought that a crash programme would divert scarce resources from newly developed fission weapons. President Harry Truman did not heed to the Committee's opposition and approved a crash programme for the hydrogen-bomb. Oppenheimer wanted to resign from the Chairmanship of the Committee but his resignation was not accepted.

*Oppenheimer with Einstein*

After the war ended, Oppenheimer decided to return to academic life again. General Groves, though reluctantly, accepted Oppenheimer's resignation. Before leaving the Los Alamos, Oppenheimer accepted the certificate of appreciation from the Army to the Los Alamos Laboratory. On this occasion Oppenheimer said: "If atomic bombs are to be added to the arsenals of the world, or the arsenals of the nations preparing for war, then the time will come when mankind will curse the name of Los Alamos and Hiroshima. The peoples of the world must unite or perish. This war, that has ravaged so much of the earth, has written these words. The atomic bomb has spelled them out for all men to understand. Other men have spoken them, in other times, in other wars, or other weapons. They have not prevailed. There are some, misled by a false sense of human history, who hold that they will not prevail today. It is not for us to believe that. By our works we are committed, committed to a world united, before the common peril, in law and in humanity."

In 1947, Oppenheimer was appointed as Director of the Institute for Advanced Study in Princeton. At that time the most important member of the Institute was Albert Einstein. At Princeton Oppenheimer himself did not do much research but he certainly inspired his collaborators. He made the Institute a centre of young physicists. Bethe wrote: "…on Oppenheimer's arrival, the physics department of the Institute changed. While its emphasis had been on well-established professors before, it now became a centre for young physicists. Five research associates from Berkeley came with him in 1947. Thereafter the Institute was open to dozens of post-doctoral fellows, from the United States and abroad. Even more than Berkeley in the 1930's, the Princeton Institute became the centre of physics. Nearly everybody who was anybody passed its stimulating atmosphere."

In 1953, his political background and his support for making the hydrogen bomb was questioned. In fact Oppenheimer was under investigation since 1942, first as a matter of routine and then more rigorously when reports critical of his loyalty to the interest of the State, began to arrive at the office of Colonel Pash, the in-charge of security at Los Alamos. He came under suspicion because some of his friends had been members of the Communist Party

*President Lyndon Johnson presenting US Atomic Energy Commission's Enrico Fermi award to Oppenheimr. (J. Robert Oppenheimer Memorial Committee)*

and also because he moved freely in left-wing circles. Joseph McCarthy, one of the most conservative Senators in the US Congress started investigating Oppenheimer's communist links. The Joint Congressional Committee on Atomic Energy also started an investigation into Oppenheimer's past. The Joint Committee brought out a series of damaging charges against Oppenheimer. Alarmed by the charges brought out by the Joint Committee against Oppenheimer, the Atomic Energy Commission began investigating against Oppenheimer. He was asked to resign from the post of Chairman of the General Advisory Committee but when Oppenheimer refused to do so, the Commission ordered the proceedings of the trial against Oppenheimer. The hearings ran from April 5 until May 6, 1954. On June 28, 1954, the US Atomic Energy Commission stripped Robert Oppenheimer of his security clearance. Though Oppenheimer was not found guilty of espionage but the Commission judged that Oppenheimer possessed "substantial defects of character and imprudent dangerous associations (with) known subversive" and so he could not be trusted anymore with military/government secrets. After this Oppenheimer found himself cut off from inside circles of nuclear policy. Oppenheimer accepted his downfall with grace.

The Atomic Energy Commission trial had its effect on the personal life of Oppenheimer. His brother Franck was dismissed from his teaching job at the University of Minnesota because of his former ties to the Communist Party. A number of friendships and personal associations were either severed or strained. But there were people who lent him their emotional support. Among them were Hans Bethe, Niels Bohr and one of his former colleagues at Caltech and Los Alamos.

In 1963, the General Advisory Committee elected Oppenheimer for its Enrico Fermi Award for excellence in the field of nuclear research. The award was to be presented by President John Fitzgeral Kennedy (1917-63). But two weeks before the award ceremony, President Kennedy was assassinated on November 22, 1963. Finally, the President Lyndon Baines Johnson (1908-73) presented the award on December 02, 1963.

Oppenheimer had a complex personality. He took interest in a number of human activities including religion. Isador Isaac Rabi (1898-1988): "[Oppenheimer] was overeducated in those fields which lie outside the scientific tradition, such as his interest in religion, in the Hindu religion in particular, which resulted in a feeling of mystery of the universe that surrounded him almost like a fog. He saw physics clearly, looking toward what had already been done, but at the border he tended to feel there was much more of the mysterious and novel than there actually was."

Not long after this award ceremony he returned to California to join the Faculty of the California Institute of Technology in Pasadena. The success of the atomic bomb had made Oppenheimer a well-known and highly respected public figure. He was no more a simple theoretical physicist. At California he again started doing research in theoretical physics. He succeeded in publishing a few research papers.

There are two books by Oppenheimer. The first book, *Science and the Common Understanding* (1954) offers a firsthand look at physics, quantum mechanics and the role of scientist in modern society. The second book *The Open Mind,* (1955) is based on lectures given by Oppenheimer during 1946 and 1954. In these lectures Oppenheimer addressed the problems of atomic weapons and the relationship between science and society.

Oppenheimer died on February 18, 1967 at his home in Princeton. He was 62 years old.

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# Caraway

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Called Gunyan, Shia jeera, Vilayati jeera in Hindi, Perum Jerragam (or Seemai Jeeragam) in Tamil, Caraway appears like cumin but is very distinct species and spice. In like manner, though caraway are usually but incorrectly called "caraway seeds" but are actually fruits of the plant *Carum carvi L.* Caraway seeds are the main part of the plant used, although the entire plant is edible. The roots can be cooked like carrots or parsnips, and the young leaves can be used in salads or as a seasoning.

Caraway is cultivated from Central Europe to Asia; it is not clear, however, whether caraway is truly indigenous to Europe. Today, it is chiefly cultivated in the Netherlands, Eastern Europe and Germany, former USSR furthermore North Africa, particularly Egypt. It is cultivated in a limited scale in Kashmir, Kumaon, Garhwar and Chamba area in India; however at present the cultivation is inadequate to meet the domestic needs and India resorts to imports.

*Figure 1: Caraway 'seeds; (fruits)*

## Culinary uses

(Caraway is often recognized the the most typical spice of the German-speaking countries. It is an ancient spice of Central Europe: Caraway fruits have indeed been found in neolithic villages and since Roman times there is plenty of documentation for numerous culinary and medicinal application. Although caraway is a common plant of Alpine meadows at low elevation, is was grown systematically in medieval monasteries, mainly to to its extremely effective antiflatulent powers).

*Figure 2: Plant and Fruit*

## History

The use of caraway as a medicinal agent has remained unchanged for centuries. Its use as a digestive aid was first mentioned in the Egyptian *Eberus Papyrus* about 1500 BCE. In Caraway is one of the world's oldest culinary spices. It was used to flavour bread eaten by Roman soldiers. The ancient Egyptians always placed a container of caraway in tombs to ward off evil spirits.

Caraway was well known in classic days, and it was believed that its use originated with the ancient Arabs, who called the 'seeds' Karawya, a name they still bear in the East, and clearly the origin of our word Caraway and the Latin name Carvi, although Pliny would have us believe that the name Carvi was derived from Caria, in Asia Minor, where according to him the plant was originally found. In old Spanish the name occurs as Alcaravea. Caraway is frequently mentioned by the old writers. Dioscorides advised the oil to be taken by pale-faced girls. In the Middle Ages and in Shakespeare's times it was very popular.

'The seed,' says Parkinson, 'is much used to be put among baked fruit, or into bread, cakes, etc., to give them a rellish. It is also made into comfites and taken for cold or wind in the body, which also are served to the table with fruit.' Shakespeare's Henry IV, the character Falstaff is invited to have a serving of baked apples and caraway ['a last years pippin (apple), with a dash of caraways'] to aid the digestion and relieve gas. The custom of serving roast apples with a little saucerful of Caraway is still kept up at Trinity College, Cambridge, and at some of the old-fashioned London Livery Dinners, just as in Shakespeare's days - and in Scotland to this day a saucerful is put down at tea to dip the buttered side of bread into and called 'salt water jelly.'

The scattering of the seed over cakes has long been practiced, and Caraway-seed cake was formerly a standing institution at the feasts given by farmers to their labourers at the end of the wheat-sowing. The little Caraway comfits consist of the seeds encrusted with white sugar. In Germany, the peasants flavour their cheese, cabbage, soups, and household bread with Caraway, and in Norway and Sweden, polenta-like, black, Caraway bread is largely eaten in country districts. The oil extracted from the fruits is used as an ingredient of alcoholic liquors: both the Russians and the Germans make from Caraway a liqueur, 'Kummel,' and Caraway enters into the composition various cordials.

A curious superstition was held in olden times about the Caraway. It was deemed to confer the gift of retention, preventing the theft of any object which contained it, and holding the thief in custody within the invaded house. In like manner it was thought to keep lovers from proving fickle (forming an ingredient of love potions), and also to prevent fowls and pigeons from straying.

Caraway is a spice mostly loved in Northern, Central and Eastern Europe; languages of other regions often lack a specific name for caraway, but use the name of cumin instead, often with a geographic epithet referring to

Germany: Turkish frenk kimyonu “Frankish cumin”, Italian cumino tedesco (Finnish saksankumina) “German cumin” or Hindi vilayati jeera “foreign cumin”.

Caraway is the spice that gives Southern German and Austrian foods, be it meat, vegetable or rye bread, their characteristic flavour. It is also popular in Scandinavia and particularly in the Baltic states, but is hardly known in Southern Europe. True caraway aficionados use the whole fruits, but even the powder is strongly aromatic. Caraway’s aroma does not harmonize with most other spices, but its combination with garlic is effective and popular in Austria and Southern Germany for meat (e.g., roast pork Schweinsbraten) and vegetables. German Sauerkraut (sour cabbage made by lactic fermentation) is always flavoured with caraway. Unfermented boiled cabbage without caraway lacks character. Some cheese varieties from Central Europe contain caraway grains. Caraway is of some importance in the cuisines of North Africa, mostly in Tunisia. Several recipes of Tunisian harissa, a fiery paste made of dried chilles, call for caraway, and the same is true on a similar preperation found in Yemen, Zhoug. In India caraway is mostly used in Mugal cusines.

*Figure 3: The plant*

Sensoric quality of Caraway is strongly aromatic and warm and thus is a controversial spice; to many, it appears dominant and unpleasant, especially to those who are not used to a cuisine rich in caraway. Like garlic, usage of the ground spice is a working compromise.

## Botany

Caraway is another member of the group of aromatic, umbelliferous plants characterized by carminative properties, like Anise, Cumin, Dill and Fennel. It is grown, however, less for the medicinal properties of the fruits, or so-called ‘seeds,’ than for their use as a flavouring in cookery, confectionery and liqueurs. The plant is a perennial or biennial herb, grows to about 0.6 m and has feathery, compound leaves. The roots are tuberose and thick and the flowers are small and white borne on umbels. It blooms every two years to produce large creamy flowers. The fruits, which are popularly and incorrectly called seeds - and which correspond in general character to those of the other plants of this large family, are laterally compressed, somewhat horny and translucent, slightly curved, and marked with five distinct, pale ridges. They evolve a pleasant, aromatic odour when bruised, and have an agreeable taste. The seeds are mericarps as each seed is a half of the fruit. Each single seed or carpel is about 0.5 cm long, tan to brown, and curved with five lighter coloured ridges along the length of the seed. Buyers look for a dark brown colour in the valley between each ridge. The leaves possess similar properties and afford oil identical with that of the fruit. The tender leaves in spring have been boiled in soup, to give it an aromatic flavour. The roots are thick and tapering, like a parsnip, though much smaller and are edible. Parkinson declared them, when young, to be superior in flavour to Parsnips. Mixed with milk and made into bread, they are said to have formed the ‘Chara’ of Julius Ceasar, eaten by the soldiers of Valerius.

Caraway plants with small roots (less than 13 mm in diameter) at the start of the second growing season usually do not produce seed. They remain vegetative through the growing season and produce seed the following year. Caraway plants with larger roots (greater than 13 mm) at the start of the growing season will usually flower and produce seed.

## Chemical composition

The basic flavour of Caraway comes from a chemical named carvone; it is balanced in almost equal measure by another chemical limonene which most people identify as lemony. It is this combination of the spicy sweetness which undertaste of lemon that makes caraway such a pleasant addition to fruit desserts. Caraway fruits may contain 3% to 7% essential oil. The aroma of the oil is mostly dominated by carvone (50 to 85%) and limonene (20 to 30%); the other components carveol, dihydrocarveol, a- and a-pinene, sabinene d-dihydropinol and d-perillyl alcohol are of much minor importance. The oils of caraway grown in different locations differ from each other in quantity, quality, and composition. An inferior oil, caraway chaff oil, is obtained from husks and stalks and used for scenting soaps.

## Medicinal and other uses

Both fruit and oil possess aromatic, stimulant and carminative properties. Caraway was widely employed at one time as a carminative cordial, and was recommended in dyspepsia and symptoms attending hysteria and other disorders. Aromatic volatile oils of Caraway stimulate the digestive system to work properly and with ease, soothing the gut wall, reducing any inflammation that might be present, easing griping pains and helping the removal of gas from the digestive tract, thus is said to be carminative. It possesses some tonic property and forms a pleasant stomachic. Its former extensive employment in medicine has much decreased in recent years, and the oil and fruit are now principally employed as adjuncts to other medicines as corrective or flavouring agents, combined with purgatives.

Irritable bowel syndrome (IBS) is a very common gastrointestinal disorder that sometimes causes significant discomfort even though it is not a serious health threat.

Essential oil of both Caraway and spearmint leaf consist predominantly Carvone ($C_{10}H_{14}O$). However they both smell quite distinctly. The odor of a molecule depends on its shape and dipole. The olfactory area of the nose has a system of receptor cells of several different types and shapes. Seven basic receptors are postulated. Nonetheless little variation in the chemical structure makes mountain of difference as to how they smell. For example putrid and pungent receptor site appear not to correspond to a particular shape but rather to the dipole of the molecule. In like manner very subtle differences in structure can produce different odors. For example, the difference between R-carvone and L-carvone is that in R-carvone, the hydrogen near the asterisk is below the double-bonded carbon, but in L-carvone, the H is above the C. double bond. In all other respects, the structures are identical. Although both are in the minty category, their odors are distinct.

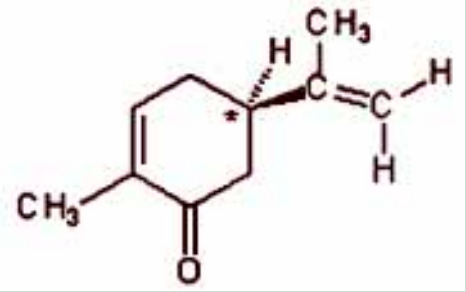


*Figure 4: Carvone-R : Present in Caraway*

Receptor sites are chiral, therefore it might be expected that two enantiomers smell different. This is in fact the case in many instances; for example odors of spearmint [major component is carvone L] and caraway [largely carvone R].

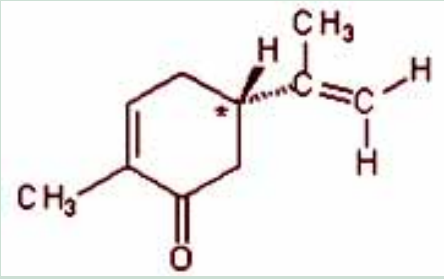


*Figure 5: Carvone L: Present in Spearmint leaf*

The cause of IBS remains unknown. Caraway is said to be a suitable home remedy to sooth the IBS.

Traditional use of Caraway for Dental Disease, Gum Disease, Periodontal Disease and Gingivitis is reported. Gingivitis is an inflammation of the gums (gingivae), caused by bacteria. Periodontitis is a deeper and more serious inflammation of both the gingivae and tissue that surrounds and supports the teeth. These common conditions are often progressive and can eventually result in loss of the underlying bone that supports the teeth. After age 30, periodontal disease is responsible for more tooth loss than are dental cavities. Severe periodontitis sometimes requires surgery to repair damaged gum tissue.

For flatulent indigestion, caraway is found efficacious. Distilled Caraway water is considered a useful remedy in the flatulent colic of infants, and is an excellent vehicle for children's medicine. Colic is a common problem in infants, where the baby is healthy but has periods of inconsolable crying, apparently caused by abdominal pain. Colic usually develops within a few weeks of birth and disappears by the baby's fourth month. When sweetened, caraway flavour is agreeable and thus it is presently used as a flavouring agent. The powder of the seeds, made into a poultice, will also take away bruises. Most activity of caraway comes from the volatile oil, which is a mucuous-membrane irritant. Oil of caraway is reported to have antibacterial properties. The ketone carvone and terpene limonene, ingredients of the essential oil, can cause contact dermatitis

The oil is also used as a fragrance component in cosmetic preparations including soaps, creams, lotions and perfumes. Its flavour and aroma are used in mouthwash and gargle preparations as well as .

Carvone is a natural product which can be isolated both from caraway seeds (S-(+)-carvone) or from mint (R-(-)-carvone). These compounds have been applied as a starting material for the synthesis of several more complex natural products of agricultural or medical relevance, as well as fragrance compounds. A few examples are the biologically active compounds a-cyperone and trimethyldecalol, the insect antifeedant drimanes and dihydroclerodin and the fragrance compounds geosmin and ambrox. Preliminary research has demonstrated that it should also be possible to use carvone as starting material for the synthesis of steroids.

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**(Editorial) A Satellite for Education....** Contd. from page 35

**T**echnology. The credo for the channel would be - science is everywhere and for everyone. DECU and Vigyan Prasar are partners in managing the channel as well as production of software. Initially, however, it is planned to launch a pilot project on Doordarshan and then gradually shift to the EDUSAT channel.

Indian Science and Technology must make a greater difference to the lives of our people – this is what Dr. Manmohan Singh, Hon'ble Prime Minister of India, had said at the Shanti Swaroop Bhatnagar Awards ceremony recently. EDUSAT will strive to meet that objective and as predicted by Mr. G. Madhavan Nair, Chairman, ISRO, it would propel India into a leadership role in distance education. The benefits of EDUSAT could even reach beyond India's borders. As EDUSAT covers other South Asian countries partially or fully, it should be possible to extend support to those countries too, according to Mr. Nair.

**❒ V. B. Kamble**

# A Sense of Smell

## Nobel Prize 2004 — Physiology or Medicine

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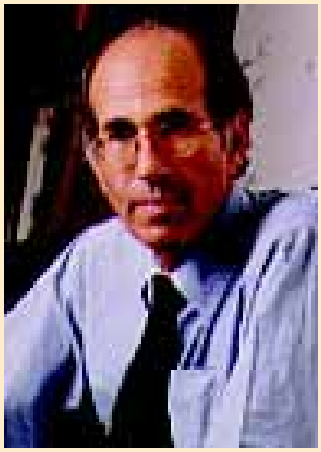
While waiting for your dinner to be served, you may be elated identifying the smell of the food that you love the most. When some foods taste good, it is due to the primary activation of our olfactory system that helps us to sense the smell of substances. Again it will be an instantaneous action from your part when the smell gives you the telltale sign indicating that the food is unfit for consumption. The olfactory system of our body gives us the important signals that change our feelings, emotions, behaviour, actions etc.

Minute chemical substances or odorant molecules emitted from an object activate the odorant receptors in our nasal (olfactory) epithelium, which in turn trigger our olfactory system through which we can sense the smell. The smell is an important part of our daily life, which changes our responses to different situations according to how we perceive the smell. The sweet smell of a rose and the acrid smell of smoke will put us completely in two different situations. A unique smell may revive the distinct memories from our childhood or different emotional moments in some part of your life. That's the power of smell!



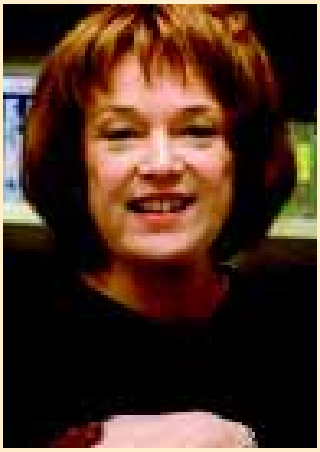
*Richard Axel*

The mechanism on how we sense smell was shrouded with mysteries until very recent time. Two pioneering scientists from USA who deciphered the riddles on functioning of olfactory system were awarded the 2004 Nobel Prize in Physiology or Medicine by the Nobel Assembly at Karolinska Institute, Sweden. They are Richard Axel, an Howard Hughes Medical Institute (HHMI) investigator at Columbia University College of Physicians and Surgeons, New York, and Linda Buck, an HHMI investigator at the Fred Hutchinson Cancer Research Center, Seattle. They were awarded the prize for their discoveries of odorant receptors and the organization of the olfactory system.

### Overview of olfactory system

Before understanding the works of those two scientists, let's first take a look at the simplified version of the mechanism of the olfactory system that was known before the publication of their pioneering works. In a small area in the upper part of the nasal epithelium, there are minute hair-like cilia that protrude into a thin bath of mucus at the cell surface. Somewhere on these cilia, scientists believe that there must be some receptor proteins or odorant receptors that recognize and bind odorant molecules. Once any odorant substance binds to these receptors, they are stimulated and send the information to neuronal cells or olfactory receptor cells. As the neuron is excited, the electric signal travels along nerve cell's axon and transferred to neurons in the olfactory bulb of the brain. From the olfactory bulb, the signal is relayed to both the higher cortex and limbic system of the brain. The brain tells us the message lying under that signal after deciphering that complex sensory signal.

In the late 1980s, Reed and his co-workers first demonstrated specialized elements of a G protein signalling pathway in neurons that detect odours. G proteins are special group of proteins that derive energy from a compound called guanosine triphosphate. These G proteins sit below the receptors and poke through the cell membrane. When the receptor recognizes the right kind of molecule, it first activates a G protein, to which it is coupled. The G protein in turn stimulates the formation of cyclic AMP (cAMP). This messenger molecule activates ion channels, which are opened and the cell is activated and a cascade of biochemical signals inside the cell is initiated. Some biochemical and physiological studies had also implicated G proteins in odour signalling.



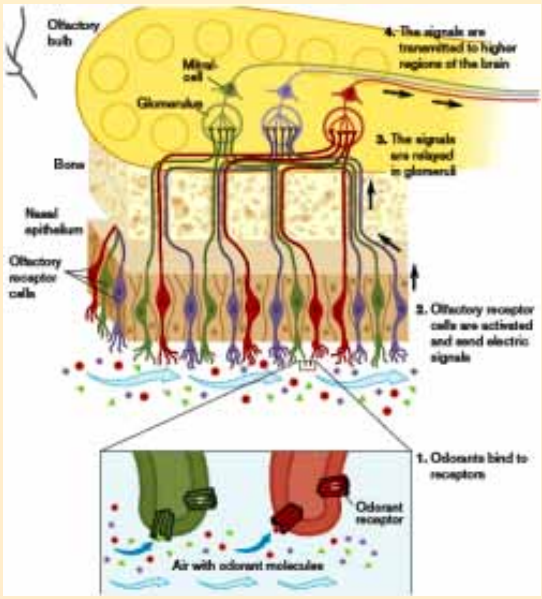
*Linda B. BucK*

### Odorant receptors and olfactory receptor cells

The basic nature and characteristic features of those odorant receptor molecules as well as how they work in conjunction with the G protein were still unclear during early 90s. A straightforward strategy to elucidate the functionalities of those receptor proteins could have been done by directly studying those proteins. But Richard Axel and Linda Buck had taken a different approach. They tried to look for genes that contained instructions for receptor proteins. The DNA or deoxyribonucleic acid contains the information of protein in triplicate nucleotide code. The DNA is transcribed to messenger ribonucleic acid (mRNA), and according to the amino acid sequence scripted in the mRNA, it is translated into protein. Therefore examining the information encoded in DNA sequences is an effective approach to identify the characteristics of proteins that the DNA molecules code for. Unfortunately, their initial studies did not yield any important information in this direction.

However, they did not lose their hope after obtaining these disappointing outcomes. But the results gave them some important clues of possible mechanisms. Soon they realized that their initial scheme failed because there might be a large number of odorant receptors and each was expressed at a very low level. So their approach to find few hits for receptor proteins among thousand of genes was unsuccessful.

Buck then made some assumptions that drastically narrowed the field, allowing her to zero in on a group of genes that appear to code for the odorant receptor proteins. Her first assumption was based on evidences from various laboratories. She observed that the odorant receptors look a lot like rhodopsin, the receptor protein in rod cells of the eye. Rhodopsin and at least 40 other receptor proteins consist of chain of amino acids that is anchored into the cell membrane and criss-crosses the cell surface seven times, which gives them a characteristic snake-like shape. They also function in similar ways by interacting with G proteins to transmit signals to the cell's interior. Since many receptors of this type share certain common DNA sequences, she soon designed probes of small DNA sequences that would recognize these sequences in a pool of rat DNA.




*Organization of the olfactory system*

Next, she assumed that the odorant receptors are members of a large family of related proteins. All the odorant receptors are related proteins but differ in certain details, explaining why those are triggered by different odorous molecules. So she looked for groups of genes that had certain similarities.

She finally assumed that expression of genes occur only in a rat's olfactory epithelium. Since the receptors are very much localized only in rat's olfactory epithelium, therefore this assumption would be helpful for screening expression of protein only in a small localized area and studying fixed number of expressed proteins. This would also help in reducing the time and efforts for searching the possible genes for odorant receptors.

Axel termed these assumptions as 'extremely clever twist'. He remarked, 'Had we employed only one of these criteria, we would have had to sort through thousands more genes with several years of drudgery.' And Axel was very much right. In 1991, Buck and Axel published their work in the journal *Cell* on the novel multigene family that might encode odorant receptors and described the molecular basis for odour recognition. They discovered a large gene family, comprised of some 1,000 different genes that account for three percent of total number genes that we have. They showed that the large family of odorant receptors belongs to the G protein-coupled receptors (GPCR). All these genes give rise to an equivalent number of olfactory receptor types. None of them had ever been seen before or described in published documents. They were all different but all related to each other.

The next question was how many of these 1,000 receptor proteins are made in a single olfactory neuron. To find the answer to this question, Axel and Buck independently conducted experiments to examine the molecular logic behind the olfactory system. They showed that every single olfactory receptor cell or neuron expresses one and only one of the odorant receptor genes. Thus, there are as many types of olfactory receptor cells as there are odorant receptors.

Buck's research group examined the sensitivity of individual olfactory receptor cells to specific odorants. They noted exactly which odorant receptor gene was expressed in a cell exposed to specific odorant. In this way, they could correlate the response to a specific odorant with the particular type of receptor carried by that cell. Moreover, when they recorded the electrical signals coming from single olfactory receptor cells, they observed that each cell can react to several related molecules with varying intensity. Our olfactory receptor cells are therefore highly specialized for a few odours.

In another set of studies, they observed that neurons that make a given odorant receptor are not clustered together, but are instead randomly distributed within regions of the olfactory epithelium. Hence several interesting information came out from these set of unique studies. They concluded that each olfactory receptor cell possesses only one type of odorant receptor, each receptor can detect a limited number of related odorant substances and odorant receptors are distributed randomly in the olfactory epithelium.

These findings give rise to a small confusion. There are only 1,000 odorant receptors, but we can recognize approximately 10,000 odours from memories. How is it possible? The answer is very simple. Most odours are composed of multiple odorant molecules, and each odorant molecule activates several odorant receptors. This leads to a combinatorial signal, which forms an odorant pattern. This is the basis for our ability to recognize and form memories of approximately 10,000 different odours.

### Glomeruli in olfactory bulb

The finding that each olfactory receptor cell only expresses one single odorant receptor gene was highly unexpected. To delve more into the mystery of this signalling mechanism, Axel and Buck continued their experiments to determine the organization of the first relay

station in the brain. The olfactory receptor cell sends its nerve processes to the olfactory bulb, the primary olfactory area of the brain. In olfactory bulb, there are some 2,000 well-defined micro-domains called glomeruli. There are thus about twice as many glomeruli as the types of olfactory receptor cells. Receptor cells carrying the same type of odorant receptor converge to the same glomerulus. The convergence of information demonstrated that also glomeruli exhibit remarkable specificity. The result is a highly organized spatial map of information derived from odorant receptors.

The nerve processes in glomeruli make their contacts with the next level of nerve cells, the mitral cells. This is the second relay station in the brain. Each mitral cell is activated only by one glomerulus, and the specificity in the information flow is thereby maintained. The mitral cells send the information to several parts of the brain through long nerve processes. Buck showed that these nerve signals in turn reach defined micro regions in the brain cortex. Here the information from several types of odorant receptors is combined into a pattern characteristic for each odour. Odour signals are relayed to higher cortex of brain that handles conscious thought processes and to the limbic system that generates emotional feelings. The signal is interpreted and leads to the conscious experience of a recognizable odour. For example, we can consciously experience the smell of a rose and recall this olfactory memory at other times.

### Other directions

The general principles that Axel and Buck discovered for the olfactory system are applicable to other sensory systems. Pheromones are chemical molecules that can influence different social behaviours, especially in rodents. Rodents can detect and process these chemosensory signals or pheromones and act accordingly. Axel and Buck discovered that pheromones are detected by two other families of G protein coupled receptors (GPCR) localized to a different part of the nasal epithelium. The taste buds of the tongue have another family of GPCR, which is associated with the sense of taste. In 1995, Axel and Dulac used a novel cloning strategy to show that pheromone receptors are encoded by a family of genes expressed in the vomeronasal organs (VNO) of rats. Two years later, Dulac and Buck found yet another set of pheromone receptors with its own family of genes in VNO of mice and rats.

All living organisms can detect and identify chemical substances in their environment. It is obviously of great survival value to be able to identify suitable food and to avoid putrid or unfit foodstuff. The works of Axel and Buck not only elucidated the complex mechanisms of olfactory system but their basic works also accelerated works of other researchers to find out genes for similar receptor proteins in other species. The genes for odorant receptors of humans, mice, catfish, dogs and salamanders have been identified by searching the DNA libraries of these species.

### Speaking about smell

- Anosmic: One who has lost some or all of their sense of smell. The condition is called anosmia.
- Dogs have 1 million smell cells per nostril, and their cells are up to 100 times larger than those of humans.
- Proust effect: Marcel Proust observed this phenomenon of memory recall in response to a specific smell. In this condition, whole memories completed with all associated emotions can be prompted by smell. This is entirely unconscious and cannot necessarily be prompted voluntarily.
- Volatile notes: Perfumers describe the most volatile components in a fragrance as head notes. For a fine fragrance, these evaporate and diffuse away in the first fifteen minutes after application to the skin, making the largest contribution to the initial smell. Less volatile notes are responsible for the heart of the fragrance and make the largest contribution over the next three to four hours. Finally the least volatile end notes are left for the base - the final five to eight hours, giving a depth and tenacity to the fragrance theme.
- E-nose: The food industry is gradually starting to use e-noses (electronic noses) as part of the quality supply chain to reduce costs. Researchers at Cranfield University in the UK reported they had come up with an e-nose for the early detection of 'undesirable off-odours and microbial contaminants' in dairy and bakery products. This can be used to quickly detect bacteria, yeasts, filamentous fungi and off odours.

Fish has about one hundred odorant receptors while mouse has about one thousand. Humans have a somewhat smaller number than mice as some of the genes might have been lost during evolution. The area of the olfactory epithelium in dogs is approximately forty times larger than in humans which might be a reason for better sensing capability of the canine.

Both Axel and Buck are still independently working on more advanced areas of olfactory mechanism using advanced molecular and cellular biology techniques. Their research achievements in drawing the complex sensory map of olfactory information and identifying the mechanisms are indeed noteworthy. Therefore the award of 2004 Nobel Prize in Physiology or Medicine to these two great scientists is an acknowledgement of their towering achievements.

**Source:**

1. *Press release from Nobel Foundation*
2. *www.hhmi.org*
3. *http://en.wikipedia.org*
4. *www.cf.ac.uk*

# Tooth Guard

## Preventive Against Cavities

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Man's tryst with dental cavities is perhaps as old as the advent of life itself on mother earth. Excavated human remains of the neolithic age bear testimony to this strange fact. Digging at some ancient human sites, anthropologists have found well-preserved human jaws with tooth cavities.

Still, until life got caught in the web of civilization and man's gastronomic preferences changed for the worse, few of man's tribe suffered the rot. In time, however, life evolved, and *Homo sapiens* turned away from their natural high-fibre diet. Raw food was replaced more and more by processed food. High carbohydrate foods, sweet delicacies, nectars and syrups became the favourite. The Lactobacillus bacteria—that inhabited the mouth, found this change favourable. Tooth decay and dental cavities became common.

Today, most people suffer dental caries at some time in their lives. Even though, much progress has taken place in dental treatments and today, dental surgeons can easily eliminate cavities and if need be replace worn out teeth, the treatment is so expensive that it is best to follow a preventive drill.

### What causes dental cavities?

Community surveys indicate that dental cavities are extremely common. The condition is found at all ages. Children, adults and old people—it spares none. Usually, the process of tooth decay begins with a build up of plaque—a deposit of food particles, saliva and Lactobacillus bacteria—on the surface of the teeth. The bacteria in plaque break down the sugar in food to produce lactic acid that erodes the tooth enamel. The process is gradual and progressive. The condition begins as a small cavity in the hard tooth enamel (the protective outer covering of a tooth). If left untended, the decay eventually penetrates the enamel and attacks the dentine, the softer material that makes up the bulk of the tooth. As the tooth decay progresses, the pulp of the tooth gets affected. If it gets infected, the tooth may die.

Further delay in treatment is fraught with serious risk. The tooth infection may spread to the jawbone. This may cause osteomyelitis of the bone. The bacteria can also enter into the bloodstream and lodge in the heart. This can lead to sub acute bacterial endocarditis, a dangerous condition.

### Simple Rules to Prevent Tooth Decay

Bacteria and other enamel thieves work hand in hand to promote and hasten tooth decay, but you can quell them and leave them no ground or concessions to act upon.

The accusing finger, to a large extent, points towards our eating habits. The foods that we prefer, the taste buds that amuse and please us, the way we eat our food and the rush we are always in, just do not gel with the structure of our teeth.

Follow these simple rules and you may win the battle against dental decay:

**Chew your food thoroughly and eat slowly** : Eating hastily or quickly gobbling down your food is simply unhealthy. It works poorly for the teeth, gums and digestive system. Always chew food well. Never rush. Know that chewing is a natural cleanser—it stimulates the flow of saliva which washes the teeth and cleans them of sticky food particles.

**Switch over to a fibre-rich diet** : Always take plenty of high-fibre natural foods. Fruits such as *guavas* and apple, sugarcane, salads and vegetables can be valuable allies in fighting cavities. Chewed after a meal, they can clean your teeth well.

Salads and fruits also make a good snack. They cut down on bad cholesterol, work well for the bowel and act as smart cleanser for gums and teeth.

**Sticky sweets are big enemies** : Yes, they are terrible. Chocolates, cookies, cakes, pastries, candies, sweets, jam, ice cream and the like get lodged in tooth crevices, particularly the molars. They offer a feast to the Lactobacillus bacteria which produce a variety of organic acids, including lactic acid, that are injurious to dental enamel.

**Shun table sugar** : The effect of sugar-laden foods on


***Structure of a Tooth***

*The sensitive nerves and blood vessels at the centre of each tooth are protected by several layers of tissue, the outermost – enamel – being the hardest substance in the body. Under the enamel, surrounding the pulp from crown to root, lies a layer of bonelike dentin. A hard tissue called cementum separates the root from the periodontal ligament, which in turn holds the root in place and cushions the tooth against the gum and jaw during the grinding, jarring activity of chewing.*

teeth is well known. Table sugar, made up of a simple carbohydrate called sucrose, has the greatest potential of causing cavities. Take less and less of it.

**Less you indulge your sweet tooth, better it is :** More than the total amount of sugar eaten, it is how often you indulge your sweet tooth that really influences tooth decay. Eating one dessert a day is far less risky than eating moderately sweet food all day long. The reason is obvious: more times that you eat sugary food, higher is the risk of bacteria latching onto it.

**Cut down on soft drinks :** Sugar-laden soft drinks are equally damaging to our teeth. An experiment conducted a few years ago showed that a human tooth kept in a sealed bottle of a popular cola dissolved completely in three months. You do not want that to happen.

**Rinse your mouth :** The age-old Indian custom of *kulla* (rinsing) after every meal has much to recommend for it. Even though it may not fit into the present scheme of civilized life, where napkins are the order of the day, it is one surefire way of keeping the oral cavity clean and avoiding tooth decay.

**Take a sip :** Make a habit to sip some water after you finish your meal, particularly after feasting on sugary and starchy eats. This will clean your teeth and protect them against tartar and plaque.

**Never break your dental routine :** Whatever time constraints you may live under, always brush at least twice daily. Never drop into your bed at night before spending at least five minutes on the job. This is important because plaque—the sticky colourless deposit of bacteria—begins forming on your teeth just four to twelve hours after you brush them, and unless your brush your teeth before going to sleep, you run a high risk of letting oral bacteria do damage.

**Take an appointment with the dental surgeon :** If you find that your teeth need a service, go to your dentist. There is nothing wrong in getting them cleaned professionally. It only restores and strengthens the teeth.

A dental cavity is also best attended timely. Based on the extent of damage, sometimes a dental filling can stem the rot.

•••

# Eco-friendly Election

❑ D.N. Herlekar

General election for Lok Sabha took place in April & May 2004. Along with this election for state assemblies in some states were also held. Uptil now ballot paper was associated with all elections. Apart from this paper was being used for handbills, posters, individual voter cards etc. Along with this list of voters and other formalities required more paper. Every election the number of voters is going up, similarly number of candidates in one constituency decided the length of ballot paper as well as total paper consumption.

In 1991 election the number of voters were 51.5 crore and paper consumed for just ballot paper was about 5400 Metric Tons (M.T.) In the current election the number of voters were about 65 crore and the paper consumed for only ballot paper would have bean 6800 M.T. If we look in to the calculations of raw materials required to manufacture paper it is as follows - To manufacture one ton of paper we require 17 to 20 grown trees or 2.5 tons of bamboo. Other things required are water- 62.5 ton, steam under high pressure - 3.75 ton and substantial quantity of electricity. This results in huge residue of waste after paper manufacture which creates further problems for disposal. If you look into these facts you will agree that trees or bamboo, water, steam, electricity are all either direct natural resources or produced using natural resources. At present the position of natural resources is critical, e.g. if we consider the land, covered by forest, it should 33% of the total land but the current forest cover is around 16% only. Nobody will disagree about water scarcity. In order to prevent depletion of natural resources, we should minimize use of paper. The Election Commission has done exactly that. They have started using electronic voting machines in some parts of the country from 1998. In the current election these electronic machines are being used in all 543 Lok Sabha constituencies. This has saved 6800 tons of paper considering only ballot paper. In other words it has saved 1.25 to 1.50 lac trees from felling or 17000 tons of bamboo from cutting. The saving of water, steam & electricity is also substantial. This also prevented the residue / waste resulting from paper manufacture. Hearty congratulations to Election Commission. Hence this election should be termed as Eco-friendly election. The will power shown by Election Commission should be noted by other departments / commissions of government and use it whenever possible.

*Executive Director, Marathi Vidnyan Parishad*
Vidnyan Bhavan, V.N. Purav Marg, Sion-Chunabhatti, Mumbai-400022

# Recent Developments in Science & Technology

### EDUSAT Successfully Launched

EDUSAT was successfully launched into Geosynchronous Transfer Orbit by the first operational flight of ISRO's Geosynchronous Satellite Launch Vehicle (GSLV-F01) from Satish Dhawan Space Centre (SDSC) SHAR, Sriharikota on 20 september 2004.

The first orbit raising manoeuvre of ISRO's latest satellite, **EDUSAT** was successfully carried out by firing the 440 Newton Liquid Apogee Motor on board the satellite for a duration of 49 minutes 56 seconds at 07:48 am on September 21, 2004 by commanding the satellite from Master Control Facility (MCF) at Hassan in Karnataka. With this operation, the perigee (nearest point to earth) of EDUSAT has been raised from 181 km at the time of its injection orbit to 8800 km. The apogee (the farthest point to earth) height remains at 36,000 km.

Objectives of Education Satellite System are to meet the challenges of number and quality of education through (a) providing effective teacher training (b) supplementing the curriculum based teaching (c) greater community participation and monitoring (d) providing access to quality resource persons (e) strengthen the distance education (f) taking education to all parts of the country.

*Source: isro.org*

### Researchers Unveil Smallest Atomic Clock Yet

Scientists have manufactured the world's smallest atomic clock, with inner machinery about the size of a grain of rice. Requiring very little power to run, the device loses only one second every 300 years and could one day provide precise timekeeping for portable applications such as wireless communication devices and Global Positioning System (GPS) receivers.

Like other atomic clocks, the new design relies on the natural vibrations of cesium atoms, which "tick" 9.2 billion times each second. John Kitching and his colleagues at the National Institution of Standards and Technology trapped cesium vapor inside a chamber that is probed by a tiny laser, resulting in two electro-magnetic fields. The team then adjusted the fields until the difference between them equaled that of the energy levels within the cesium atoms, causing the atoms to stop absorbing or emitting light. An external oscillator was then stabilized against the natural resonance frequency of cesium.

Although it's about 100 times smaller, the minuscule clock is not as accurate as larger atomic clocks, which can reach up to two meters in height. But it could still offer a nearly 1,000-fold improvement in long-term precision compared to quartz crystals currently used for small-scale applications.

*Source: Scientific American Sept 2004*

## Nobel Prize for the year 2004

### Physics

*David J.Gross*
*USA*

*H.David Politzer*
*USA*

*Frank Wilczek*
*USA*

"for the discovery of asymptotic freedom in the theory of the strong interaction"

### Chemistry

*Aaron Ciechanover*
*Israel*

*Avram Hershko*
*Israel*

*Irwin Rose*
*USA*

"for the discovery of ubiquitin-mediated protein degradation"

### Physiology or Medicine

*Richard Axel*
*USA*

*Linda B. BucK*
*USA*

"for their discoveries of odorant receptors and the organization of the olfactory system"

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***(VP News) VP Participation.....****contd. from page....36*

linkages with organizations and individuals engaged in S&T popularization.

The SAARC Book Fair was held alongwith 6th International Book Fair at Colombo. Vigyan Prasar's publications were well received and many of the visitors (university professors, school teachers, government officials, science communicators) showed keen interest in the activities of Vigyan Prasar.

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