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Genetically Modified Food: Boon or Bane?

Glenn Theodore Seaborg
(A Legend in the Annals of Discovery)

(1912-1999)

Inside

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

Positive attitude towards the Earth

Students of psychology are confronted with a paradox. Precise models of attitude structure do not distinguish between the process of impression or *attitude formation* and its transformation or *attitude change*. The implication is that these models handle both processes. KJ Kaplan established that *impact mediator* influences the second – the process of attitude change. Without delving deep into sociology, the 'impact mediator' can be understood as change in the strength of initial stabilised beliefs.

Acceptance alone is operative in attitude formation or impression and this occurs fairly early in most people. (Don't we often jump to conclusions or make first impression the last impression.) Acceptance and impact both are crucial in the process of attitude change. Co-relational evidence supports this view and offers the way forward to communicators engaged in raising awareness for attitude formation and behaviour change. A lot of understanding has emerged from consumer behaviour and market researchers.

Attitudes are always towards some object that is linked to our mind (forming a bond.) This can be associative (positive link with the object) or dissociative (negative link). A person may like a social group/club and adventure sports. If this group endorses adventure sports there is *congruity*. There can be congruity also if both the group and the person do not endorse adventure sports. There will be *incongruity* if the person likes adventure sports and the club does not endorse such sports. The challenge before a communicator is to influence a desirable change in attitude.

Every April for the past four decades, many nations have celebrated Earth Day on the 22nd. Beginning with the action of Gaylord Nelson, a passionate and committed US Senator from Wisconsin, the movement has picked up momentum even as the pace of deterioration of the environment has continued to climb. Many readers have participated actively in the Earth Day celebrations in earlier years.

There is now a wide range of actions that are supported by networks of activists individually and through citizen organisations. The common people are concerned about their air, water, land and forests, and they need to tell the authorities how they feel about it. They cannot be at the receiving end of the development processes and remain silent victims. This year the elements for Earth Day can include:

- Recruiting athletes to speak for the Earth: There are role models from the recently concluded Commonwealth Games and the National Games and they can be requested to lend their voice to the environment movement.
- Trees for Earth: Dr APJ Abdul Kalam has called for every citizen to plant and adopt one sapling. Many government nurseries offer healthy saplings and necessary tips for the early care of tender plants. Housing societies, educational institutions, manufacturing plants, and defence establishments can be encouraged to plant local species of saplings and nurse them for at least a year.
- Green Schools: Early exposure to environmental action in school helps in attitude formation and many innovative ideas are affordable even by municipal and panchayat schools. This can include roof rain water harvesting, kitchen waste water recycling, composting of organic waste, etc.

Engaging women's groups, entrepreneurs, and artists creatively can be explored during this month for creation and development of sustainable models of local development that are environmentally benign.

The large community of science communicators and the growing number of active science clubs can use the occasion to raise awareness on important issues both local and global. The media – electronic, digital and print – has been properly concerned and has performed a sterling service. The aim of the campaign should be to involve and engage those who can influence opinions and policies. Ensuring a change in attitude will require study and understanding of the sociology and then applying the key lessons to make a significant difference. The task is not easy; but no worthwhile task ever is.

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Glenn Theodore Seaborg

A Legend in the Annals of Discovery

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"There is a beauty in discovery. There is mathematics in music, a kinship of science and poetry in the description of nature, and exquisite form in a molecule. Attempts to place different disciplines in different camps are revealed as artificial in the face of the unity of knowledge. All literate men are sustained by the philosopher, the historian, the political analyst, the economist, the scientist, the poet, the artisan and the musician."

Glenn Theodore Seaborg

"It is rare to name a chemical element after a living person. But Glen Seaborg had an exceptional claim to that honour. He added ten elements to the periodic table—amounting to almost a tenth of all the elements known. So the American Chemical Society, which struggled against international opposition to allow this exception, was simply recognising someone who had significantly extended its field of play when element number 106 (the last to be discovered by Dr Seaborg) was officially dubbed "seaborgium" in March 1997."

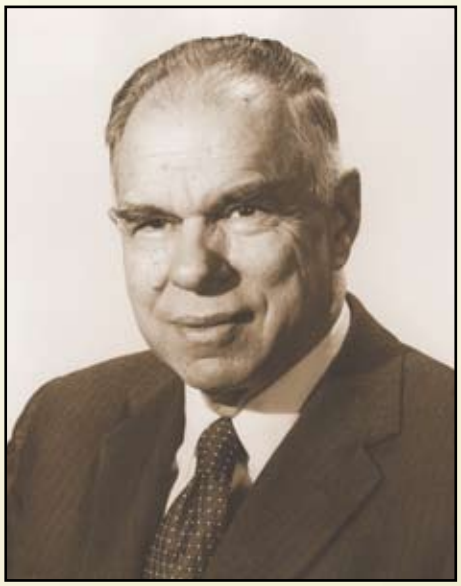
The Economist (US, 6 March 1999)

"Glenn Seaborg lived the life of a legend, exemplifying the use of heart and mind for great benefit to humankind. He will always be remembered in ^{106}Sg."

Daniel E. Koshland Jr. in *Science* (Vol.284, No.5413, p.447, 1999)

Glenn (originally Glen) Theodore Seaborg was the discoverer or co-discoverer of 10 elements namely plutonium, americium, curium, berkelium, californium, einsteinium, fermium, mendelevium, nobelium, and seaborgium. The elements discovered by Seaborg and his group are called transuranium elements; that is, elements whose atomic numbers are higher than 92, the atomic number of uranium. The first transuranium element is neptunium with atomic number 93. All transuranium elements are radioactive and they do not occur naturally. The process by which these elements are produced is called nuclear transmutation, a process in which a chemical element or isotope is converted into another through nuclear reaction in which an outside particle reacts with the nucleus of an element. Nuclear transmutation may also occur through radioactive decay where no outside particle is needed.

Naming element 106 in honour of Seaborg marked the first time an element had ever been publicly named for a living person. The popular science magazine *Discover* once noted that Seaborg could have received a letter addressed in chemical elements: seaborgium (his name), lawrencium (he worked in the Lawrence Berkeley Laboratory), berkelium (Berkeley), californium (California), and americium (America).



Glenn Theodore Seaborg

Seaborg's role in the development of the chemistry of plutonium is very significant. He developed the chemical extraction process used to isolate plutonium for the second atomic bomb as part of the Manhattan Project while working with Willard Libby at the University of Chicago's Metallurgical Laboratory. The first atomic bomb produced was a uranium bomb.

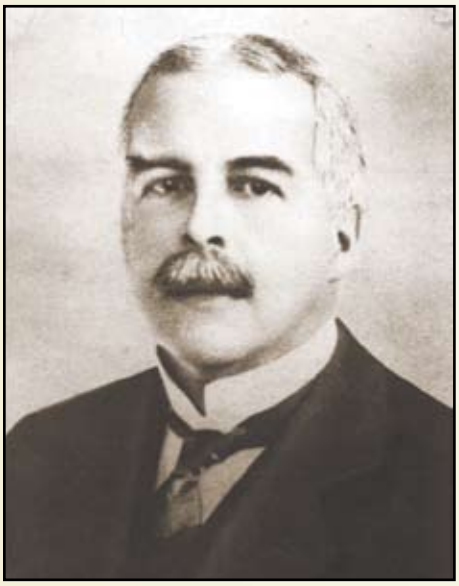
Seaborg developed the actinide concept which placed the actinide series below the lanthanide series in the Periodic Table. He also proposed the placement of super-heavy elements in transactinide and superactinide series. He made the greatest changes in the Periodic Table since the time of Mendeleev.

Seaborg is rightly regarded as the pioneer in nuclear medicine. He developed numerous radioactive isotopes of elements including iodine-131, with important applications in the diagnosis and treatment of diseases. It is interesting to note that Seaborg transmuted several thousand bismuth atoms into gold atoms by removing protons and neutrons. This was not a practical method for producing gold, but it was certainly closest to the alchemists' Philosopher's Stone.

Seaborg was the Chairman of the US Atomic Energy Commission from 1961 to 1971. As Chairman of the Atomic Energy Commission, Seaborg worked for promoting commercial nuclear energy and peaceful applications of nuclear science.

Serving as Adviser to ten US presidents on nuclear policy Seaborg played an instrumental role in nuclear arms control negotiations between the super powers of the world. He was signatory to the Franck Report, a document signed by several eminent nuclear physicists recommending that United States should not use atomic bomb to hasten Japan's surrender in the Second World War. He made significant contributions to the achievement of the Limited Test Ban treaty, the Nuclear Non-proliferation Treaty and the Comprehensive Ban Treaty.

Seaborg published more than 500 research papers and wrote several books including *A Chemist in the White House: From the Manhattan Project to the End of the*



Gilbert Newton Lewis

Cold War, A Scientist Speaks Out: A Personal Perspective on Science, Society and Change, and *Man-made Transuranium Elements*. He obtained 50 patents and supervised doctoral work of 50 students. Seaborg spent his entire academic career at California University at Berkeley, except some brief periods. The University not only shaped his career but he also shaped the University. He played a key role in establishing the Lawrence Hall of Science at California University, Berkeley as a tribute to the great physicist and his teacher Ernest Orlando Lawrence. Seaborg was the second Chancellor (1958-1961) of the University of California at Berkeley. Richard Atkinson, the President of the University of California at Berkeley said: "Glenn Seaborg gave his magnificent intellect to the world and his heart and soul to the University of California. He once said that everything he had achieved in a lifetime of towering accomplishment he owed to his association with UC. Few universities have been given so much in return. As a Nobel Prize-winning scientist who revolutionised our understanding of matter, and as a superb professor, chancellor, laboratory leader, and champion of science education for generations of California's children, Dr. Seaborg has earned a proud and permanent place in the University's history." Another President of the University, Clark Kerr said: "I consider Glenn Seaborg, among all the faculty of the University of California, to be the most distinguished in all the four areas of excellence in which we judge faculty—research, teaching, university service and service to the country. He was the best balanced, most distinguished faculty member at the most balanced distinguished university in the country."

Besides being a great nuclear scientist, Seaborg was a great educationist. He strongly believed in the importance of education in building of a nation. He played an important role in reforming the chemistry and science curricula of high schools in USA. The project named CHEM Study developed under the direction of Seaborg for improving the teaching of chemistry at high school level became an internationally recognised educational resource. He was also founder of many other science education projects including Great Exploration in Math and Science (GEMS). He was a key contributor to the report "A Nation at Risk" as a member of President Reagan's National Commission on Excellence in Education. He was the principal author of the Seaborg Report on Academic Science issued in the closing days of Eisenhower's presidency. In 1998, California Governor Pete Wilson appointed Seaborg to the Commission for the Establishment of Academic Content and Performance Standards.

Seaborg always gave credit to his teachers who had helped and inspired him. Even after winning the Nobel Prize he took utmost care to maintain his contacts with his former teachers. Besides his school teacher Dwight Logan Reid, who taught him physics and chemistry, two other teachers who encouraged Seaborg were Gilbert Newton Lewis (1875-1946) and Ernest Orlando Lawrence (1901-1958). Lewis introduced Seaborg to the idea of valence and bonding and encouraged him to work hard on his endeavours. Lawrence taught him to use the cyclotron.

Ernest Orlando Lawrence

Otto Hahn

Seaborg was born on 19 April 1912 in Ishpeming, a small iron-mining town. His parents Herman Theodore Seaborg and Selma Olivia Seaborg (nee Erickson) were of Swedish ancestry. His father was a machinist. His parents spoke Swedish at home and so Seaborg learned Swedish before English. His first school was High Street School in Ishpeming, which he joined in September 1917. Seaborg's parents with the objective of providing better educational opportunities to their children moved to Home Gardens, now a part of South Gate, near Los Angeles, California. Seaborg was 10 years old when the family moved to Los Angeles. His father could not find regular employment and the economic condition of the family worsened. Young Seaborg took up odd jobs like distributing newspaper and mowing lawns to augment the family income. He completed his school education from David Starr Jordan High School located in Watts, a suburb of Los Angeles in 1929. Inspired by his school science teacher Dwight Logan Reid, Seaborg developed a special interest in physics and chemistry. He joined the University of California, Los Angeles (UCLA)and had to support himself. He did various jobs – worked in a warehouse as a stevedore (a person employed at loading and unloading ships) and as laboratory assistant

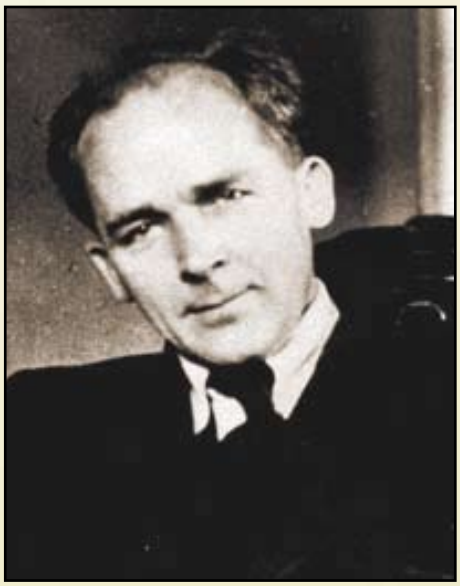
Lise Meitner

in the Firestone Tire and Rubber Company at night. He had to commute more than 30 kilometres to reach the University. He could continue his university education as the UCLA was a tuition-free public university. In 1933, he received his BA degree in chemistry and spent one year more by taking courses in physics.

In those days the Department of Chemistry of the UCLA had no facility for doing PhD studies and so Seaborg moved to California University at Berkeley (UCB). He was fascinated with the prospect of working near the great professor Gilbert Newton Lewis and the physicist Ernest Orlando Lawrence, the inventor of cyclotron. Seaborg found the atmosphere at UCB "exciting and glamorous." He obtained his PhD degree in the spring of 1937. The time was not good for finding employment as USA passing though the period of great depression. Fortunately for Seaborg he was asked by Lewis to stay at UCB as his personal research assistant. Seaborg greatly admired Lewis as his teacher and mentor. In 1939, Seaborg was appointed as Instructor and then in 1941 he was made Assistant Professor in 1941. Seaborg and J. J. Livingood produced and discovered several dozens of new radioisotopes including iodine-131 by using the newly-built 37-inch cyclotron at UCB. Many of these isotopes are still widely used in nuclear medicine. This experience eventually led him to the work of exploring the transuranium elements, which remained his life-long passion

Nuclear fission was discovered by Otto Hahn, Lise Meitner (1878-1968), and Fritz Strassmann (1902-1980) in January 1939. The news of this discovery reached Berkeley by word of mouth and prompted Edwin Mattison McMillan (1907-1991) and Philip Hauge Abelson (1913-2004) to study the fission process by bombarding uranium with neutrons at the newly-built 60-inch cyclotron and they discovered the first transuranium element with atomic number 93 called neptunium. Encouraged by their sudden success McMillan began a search for the next heavier transuranium elements. However, he could not continue his search as he had to leave Berkeley to take part in wartime research at the Massachusetts Institute of Technology. It was Seaborg with the approval of McMillan who started looking for heavier transuranium elements. In February 1941, Seaborg and his group succeeded in isolating and identifying plutonium. It was plutonium-238 and they produced it by bombarding uranium with deuteron. The isotope was found to be highly fissionable, which meant it could be utilised for producing nuclear weapons.

Seaborg was deeply influenced by Otto Hahn's *Applied Radiochemistry*. He wrote: "As a young graduate student at the University of California at Berkeley in the mid-1930s and in connection with our work with plutonium a few years later, I used his (Otto Hahn's) book *Applied Radiochemistry* as my bible. This book was based on a series of lectures which Professor Hahn had given at Cornell in 1933; it set forth the "laws" for the co-precipitation of minute quantities of radioactive materials when insoluble



Fritz Strassmann

Edwin Mattison McMillan

substances were precipitated from aqueous solutions. I recall reading and rereading every word in these laws of co-precipitation many times, attempting to derive every possible bit of guidance for our work, and perhaps in my zealousness reading into them more than the master himself had intended. I doubt that I have read sections in any other book more carefully or more frequently than those in Hahn's *Applied Radiochemistry*. In fact, I read the entire volume repeatedly and I recall that my chief disappointment with it was its length. It was too short."

In 1947, Seaborg was selected as one of America's ten outstanding young men by the US Junior Chamber of Commerce. He shared the 1951 Nobel Prize in Chemistry with Edwin McMillan "for their discoveries in chemistry of transuranium elements." He received the' National Medal of Science', the highest award of the USA given for scientific achievements, in 1991. The American Chemical Society named Seaborg as one of the "Top 75 Distinguished Contributors to the Chemical Enterprize." He was also recipient of the US Atomic Energy Commission's 'Enrico Fermi Award' (1959), 'Nuclear Pioneer Award' of the Society of Nuclear Medicine (1971), 'Order of the Legion of Honor' of the Republic of France (1973), Priestley Medal (1979), and US National Science Board's 'Vannevar Bush Award' (1988) . He was President of both the American Chemical Society and the American Association of the Advancement

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Genetically Modified Food: Boon or Bane?

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Genetic modification of food is the most radical transformation in our diet since the invention of agriculture 10,000 years ago. During these thousands of years, people have used the naturally occurring processes of genetics to gradually shape wild plants into tastier, more nutritious, and more attractive food for all of humanity. Until very recently, these evolved food plants were part of the common heritage of humankind. Food plants have been available to all as seeds for distribution, trade, and warehousing. In fact, selective plant breeding has brought food security, greater nutrition, and increased biodiversity, while at the same time protecting food systems against hard times, like natural or economic disasters.

Three features distinguish genetically modified food. First and most important, the food is altered at the genetic level in ways that could never occur naturally. As genes from plants, animals, viruses, and bacteria are merged in novel ways, the normal checks and balances that nature provides to keep biology from running amok are nullified. Exactly how genes work is a topic of enormous complexity and some controversy, so it is difficult if not impossible to predict what will happen when individual combinations of genes are created in ways that have never been seen before and then released into the environment.

The second novel feature of the revolution in our food is that the food is owned. Not individual sacks of rice, dal or atta, but entire varieties of plants and even microorganisms are now corporate products. In some cases, entire species are owned. The term "monopoly" takes on new power when one imagines a company owning major portions of our food supply, the one thing that every single person now and into the future will always need to buy.

Finally, this new technology is "globalised." This means that local agriculture, carefully adapted to local ecology and tastes over hundreds and thousands of years, must yield to a planetary monoculture enforced by intricate trade agreements and laws. According to these trade treaties, local laws that we have come to rely on for protection must take a back seat to decisions made far away by anonymous officials working in secret.

Change at the genetic level

Let us examine each of these arguments in a little detail. But before doing that let us try to understand the basic principles involved in genetic engineering of food. DNA, which is called the blueprint of life, is a molecule in a shape commonly called a "double helix," which if we could see it, would look something like a twisted ladder. The rungs of the ladder are made of what are called 'base pairs'. A gene, which is a specific sequence of base pairs, represents one unit or piece of information in the DNA, and carries instructions for the production of a protein that it codes for.. Genes, whether in humans or brinjal, provide the blueprint for producing proteins that combine with other proteins that were coded for by other genes. The interaction of huge numbers of proteins is almost unimaginably complex. The exact mechanisms by which the protein produced by any one gene contributes to a specific change or characteristic of the whole organism are only dimly understood. Because each gene codes for only one protein, it takes a great many genes to produce even a simple living organism. Corn, for example, has about 50,000 different genes, most with distinct functions. Genes are arranged linearly along the DNA molecule, which is packaged into structures called chromosomes. Every cell in a plant carries copies of all the chromosomes of the plant.

Bt brinjal

Natural species barriers make crosses between unlike living things impossible, so genetic engineers have to find ways to overcome these barriers. In genetic engineering of food crops, a gene, or piece of DNA from one source (a fish for example), is isolated, removed, and then 'inserted' into the DNA of another source, a tomato for example. The DNA of interest is removed from one living organism by enzymes that affect the chemical processes inside one organism and then moved to another organism, to be rejoined with its host's DNA in new combinations.

Foreign DNA the DNA that is brought in from another living thing is carried to the target organism by vectors. Vectors function like postmen: they are just carriers. In genetic engineering, viruses are commonly used as vectors, because viruses typically attack the host's cells and slip right into the cell's DNA.

Genetic engineers attach a piece of DNA to a viral vector and then insert the vector into the new organism so that it can infect the cells of the target organism, thus delivering the new DNA fragment into the DNA of the target. Because all this cutting

and pasting at a submicroscopic level is very difficult to keep track of, scientists often mark the vectors with antibiotic-resistant genes so that normal cells can be distinguished from genetically engineered cells. The cells are doused with antibiotics, and those cells that have incorporated the foreign DNA and the resistance genes from the vector grow, while those that haven't been modified die.

Genetic engineering is often called "genetic recombination" because it literally recombines DNA inside an organism. Several different terms are used to refer to the results of genetic engineering, such as recombined, engineered, modified, or manipulated. A crop that has been genetically engineered is often called a "transgenic" crop, meaning it contains genes from different sources.

Why genetically modified foods?

Now let us examine some arguments for adopting genetically modified foods: The world population has crossed 650 crores and is predicted to increase further at an alarming rate in the coming decades. Ensuring an adequate food supply for this booming population is going to be a major challenge in the years to come. Genetically modified, or GM foods promise to meet this need in a number of ways. People who argue for genetic modification of food list out the following points in favour of their argument.

Pest resistance: Crop losses from insect pests can be huge and crippling, resulting in financial loss for farmers and starvation in countries like ours. Farmers use many tons of chemical pesticides annually. But food that has been treated with pesticides has potential health hazards, and run-off of agricultural wastes from excessive use of pesticides and fertilisers can poison the water supply and cause harm to the environment. Growing GM foods can help eliminate the application of chemical pesticides.

Herbicide tolerance: For some crops, it is not cost-effective to remove weeds by physical means such as tilling, so farmers will often spray large quantities of different herbicides (weed-killer) to destroy weeds, a time-consuming and expensive process that requires care so that the herbicide doesn't harm the crop plant or the environment. Crop plants genetically-engineered to be resistant to one very powerful herbicide could help prevent environmental damage by reducing the amount of herbicides needed. For example, Monsanto, a biotechnology company has created a strain of soybeans genetically modified to be not affected by their herbicide product which will soon be available in India too. A farmer growing these soybeans will need only one application of weed-killer instead of multiple applications, reducing production cost and limiting the dangers of agricultural waste run-off.

Frost-resistant GM tomato

Disease resistance: There are many viruses, fungi and bacteria that cause plant diseases. Plant biologists are working to create plants with genetically-engineered resistance to these diseases. There are several success stories too like the Bt cotton and the Bt Brinjal cases.

Cold tolerance: Unexpected frost can destroy sensitive seedlings in case of crops grown in higher altitudes like apples in Himachal Pradesh and Kashmir, potatoes in Shimla, and saffron in Kashmir. An antifreeze gene from cold-water fish could be and indeed has been introduced into some plants such as potato. With this antifreeze gene, these plants are able to tolerate cold temperatures that normally would kill unmodified seedlings.

Drought tolerance/salinity tolerance: As the world population grows and more land is utilised for housing instead of food production, farmers will need to grow crops in locations previously unsuited for cultivation. Creating plants that can withstand long periods of drought or high salt content in soil and groundwater will help people to grow crops in formerly inhospitable places.

Nutrition: Malnutrition is common in third world countries where impoverished peoples rely on a single crop such as rice for the main staple of their diet. However, rice does not contain adequate amounts of all necessary nutrients to prevent malnutrition. If rice could be genetically engineered to contain additional vitamins and minerals, nutrient deficiencies could be alleviated. For example, blindness due to vitamin A deficiency is a common problem in several countries including India. Researchers have created a strain of "golden" rice containing an unusually high content of beta-carotene (vitamin A).

Pharmaceuticals: Medicines and vaccines often are costly to produce and sometimes require special storage conditions not readily available in developing countries. The oral polio vaccine is an example. Researchers are working to develop edible vaccines in tomatoes and bananas. These vaccines will be much easier to ship, store and administer than traditional injectable vaccines.

The flip side of GM food

But opponents of genetic modification of food argue otherwise. It is their contention that normally, the boundaries between species are set by nature. Until recently, those biological barriers had never been crossed. Genetic engineering allows these barriers to be crossed with results that no one can predict. It may seem bizarre or even offensive, if you are a vegetarian to think that the tomatoes you buy and eat, could have fish genes in them. Some of these combinations might be not only peculiar but downright dangerous to our environment or even our own health. Even some geneticists feel that though the

artificial nature of genetic modification does not make it dangerous, the imprecise way in which genes are combined and the unpredictability in how the foreign gene will behave in its new host results in uncertainty. From a basic genetics perspective, GM foods possess an unpredictable component that is far greater than the intended change.

They claim that the genetic engineering of food crops is a new technique that is still in its infancy. Traditional plant breeding and agricultural practices have a history that stretches back 10,000 years, and the biotechnology industry tries to tell the public that genetically engineered foods are just a natural extension of this process nothing to be alarmed about. But genetic engineering is a radical departure from traditional plant breeding. Plant genetic engineering is a hit-or-miss process. Farmers and plant breeders know that genes are mutable, and many factors, including the environment, play a major role in the expression or adaptation of a gene or genetic trait.

It is their view that classical plant breeding methods have steadily increased crop yields every year for decades. These techniques include breeding domestic crops with their wild relatives because the wild relatives provide strong survival traits that can improve domesticated crops. By relying on the birds and bees rather than the microscope and Petri dish to determine the success or failure of their new crops, classical plant breeders take advantage of nature's vast storehouse of information, accumulated over millions of years of experimentation, as to what works and what does not. It may be slow, but it ensures that no catastrophic mistakes are made.

Proponents of genetic modification argue that natural selection gave way to selective breeding of crops by human intervention and this resulted in increased yield, which in turn was improved upon by hybrid varieties, and that genetic modification is but a logical next step. But others say that there are fundamental differences between genetic engineering and traditional agriculture. Prior to the advent of genetic engineering, all selection was based on the crossing of similar plants of one variety. Acting as outside observers, humans noted what traits were most desirable and they shaped natural breeding processes to select for those traits. Farmers, familiar with breeding, cultivation, and seed collection, understood these genetic processes and so carried out their selective breeding to produce plants that fit local conditions and community standards.

With genetic engineering, the farmer is no longer needed to observe and react as a "selector." Just as hybridisation brought about enforced dependency of the farmer, along with corporate consolidation of the food supply, so does genetic engineering separate the farmer even further from the agricultural process.

Beta-carotene-rich golden rice

Genetic engineering also alters the fundamental composition of crops. The dangerous power of such technology is immense. While natural crossbreeding restricts the types of hybrids that can be produced, genetic engineering allows for gene transfers between vastly unrelated species, such as fish and tomatoes. Critics point to several instances like Recombinant Bovine Growth Hormone for increasing milk yield; the "terminator gene" technology; the Roundup herbicide, made by Monsanto; and the associated Roundup Ready seeds to establish their point that biotechnological modification of seeds will bring about disaster.

On the other hand supporters point to the Bt story. Bacillus thuringiensis (Bt) is a spore-forming bacterium that produces proteins called Cry proteins), which are toxic to many species of insects. Bt can be found almost everywhere in the world. Bt has been found in all types of terrain, including beaches, desert, and tundra habitats. There are thousands of different Bt strains, producing over 200 Cry proteins that are active against an extensive range of insects and some other invertebrates.

Being non toxic by itself, Bt is largely used in agriculture, especially organic farming. Bt is also used in urban aerial spraying programs. Since 1996 plants have been modified with short sequences of genes from Bt to express the Cry protein Bt makes. With this method, plants themselves can produce the proteins and protect themselves from insects without any external Bt and/or synthetic pesticide sprays. Other benefits attributed to using Bt include reduced environmental impacts from pesticides, increased opportunity for beneficial insects (though there are claims that ladybugs, lacewings, and monarch butterflies are harmed when they feed on engineered plants) and reduced pesticide exposure to farm workers and non-target organisms. Worldwide many plants have been incorporated with Bt genes and the effects so far seen have been beneficial. But opinion is still divided as can be seen from the protests to introduce Bt Brinjal in India.

Whatever the case may be the debate rages. While it is certain that like any new technology, genetic modification of food too has its uses and pitfalls. What makes this particular technology different is that it concerns something which forms the very essence of our life – food. If it succeeds, it will be a revolution unlike any seen in human history. If it backfires, the consequences may turn out to be anything but welcome.

Dr. Kirit Nanubhai Shelat – Promoter of village leadership

A visionary, author, philosopher, policy maker and an institution builder Dr. Kirit Nanubhai Shelat has been involved in the development of villages and village leaders to reduce the migration from villages to mega cities. After his retirement as Principal Secretary, Agriculture and Cooperation Department, Government of Gujarat, he has been associated with multi-dimensional rural programmes and actively involved in International School for Public Leadership, and National Council for Climate Change and Sustainable Development.

Dr. Shelat started his career in public administration by joining the Gujarat Administrative Service in 1967. During his career of 40 years, he has worked at the grass roots level and had his hand in the formulation and implementation of policies for agricultural, rural and industrial development. As a bureaucrat he has worked at top positions in the departments of Rural Development, Industries, Employment and Training, Disabled Persons, Energy, Gujarat Agro Industries Corporation, and Land Development Corporation. He also worked in Afghanistan as Land Settlement Advisor to Government of Afghanistan.

Dr. Shelat has designed and implemented large-scale projects for poor families, farmers, and micro entrepreneurs and has made a significant contribution in the development of Gujarat. He developed guidelines for micro-level planning with focus on individual poor family and village development plan. He was responsible for "Cluster development approach" for small industries and "Step-up project for rural micro-level entrepreneurs. He developed micro-level production plan module for the individual farmer and has been active in restructuring the Gujarat agriculture sector.

Dr. Shelat is the author of several books on development issues including Planning for Rural Development (Vol.I) – Methodology for micro-level planning for rural development (1980), and Planning for Rural Development (Vol. II)- Evolution of rural development programme – guidelines for field level officers (1982).

Er Anuj Sinha, Director, Vigyan Prasar and Consultant, Department of Science and Technology, Government of India interacted with Dr. Shelat and discussed about his achievements on rural development of Gujarat. Here are excerpts of this interaction.

Er Anuj Sinha: Sir, I am delighted that you have agreed to an interview session with DREAM 2047.

Dr. Kirit Nanubhai Shelat: Thank you very much and I am equally delighted.

Dr. Kirit Nanubhai Shelat:

In fact Dream 2047 is a very well received magazine-cum-newsletter and I congratulate you on putting it in the shape as it is now.

AS: Our readers will be interested to know about International School for Public Leadership (ISPL). How it was set up and what are its activities?

KS: As regards International School for Public Leadership, it has been promoted to meet the challenges on the leadership front. India has a rich and long history of self-governance and responsible leadership. It has emerged as the largest democracy in the world, rooted in tradition and culture. As the nation grows at a rapid pace, there are issues of poor health delivery systems, inadequate educational facilities, social conflicts, gender imbalance, and lack of infrastructure, particularly in rural areas. These gaps are against a backdrop of revolution in telecommunications and Information technology, creating long-term impact on social infrastructure and public administration. There is now an environment of opportunities, challenges and pressures for all the partners in the process of development. At the same time India is becoming a power to be reckoned with and therefore Indian leadership will have to address several core issues. All these call for creating a training hub for 'Public Leadership' where knowledgeable, committed and efficient leaders can emerge from within communities for local self governments, women SHGs, cooperatives, public and private institutions and government administration.

Mission of ISPL can therefore be summarised as: (a) Strengthening the capabilities, attitudes and behaviour of elected representatives, particularly at grass roots level; (b) Preparing the young generation to assume responsibility as elected leaders and to remain committed to the needs of the country; and (c) Preparing existing leadership to face challenges of globalisation spread of Naxalities and terrorism and issues like farmers' suicide.

ISPL has in last three years conducted more than 200 training programmes for 10,000 participants who were local level leaders and students.

AS: You are truly an institution builder. Dr Shelat, you are mentoring the National Council for Climate Change and Sustainable Development. What are its functions and what role do you envisage for this council?

KS: National Council for Climate Change, Sustainable Development and Public Leadership (NCCSD) has been formed very recently. An international conference on "Global Warming, Agriculture, Sustainable Development, and Public Leadership" was organised at Gujarat Vidyapeeth, Ahmedabad in March 2010 by the ISPL along with other organisations. The outcome of this conference, known as the "Ahmedabad Declaration 2010," articulated an action plan to promote sustainable livelihood and simultaneously mitigate impacts of global warming through appropriate use of agriculture involving public leadership. It

was decided to constitute NCCSD to give shape to this mandate. Justice B.P. Singh, former judge of Supreme Court agreed to be the head and we have wide range of members from different disciplines including you, a science communicator of eminence.

AS: The last comment is embarrassing. Climate change and development are a very complex set of challenges. The discussion rounds organised over the last few months by the NCCSD are enlarging the network. Can these dialogues help crystallise local action of mitigation and/or adaptation?

KS: I agree but I have always taken challenges head on in my long career. We are witnessing a coalition that is emerging and enlarging with every round. Experts from different fields are contributing to the dialogue. We are documenting the outcomes and these will become good reference material for policy makers.

AS: I share your vision. How can communication and outreach become more effective on issues of climate change?

KS: Communication and networking will be the key to success in this front. We need to increase the use of ICT and develop capacity building at ground level. At present computers with Internet connectivity and mobile services do exist in our rural areas.

AS: In your experience of working with village leaders, do you see the expected level of empathy, commitment and wisdom? When can our rural population really begin to experience the benefit of enlightened leadership?

KS: My experience is and has been that there is leadership which exists at individual level and community level. I have narrated experiences of Kutch in which local level leadership has played a major role greening the region in my book on Sustainable Development – a green solution to Global Warming. It describes how local population took up the challenges of adverse climate and salinity ingress and how there was convergence of efforts and successful replication of experiences. It also shows how Mr KC Shroff and family took initiatives with their NGO Vivekananda Research Training Institute (VRTI), Shrujan Trust, and Shroff Foundation. These organisations played a key role in the intervention.

AS: An effective training programme for village leaders requires structured courses, manuals, charts, films and evaluation methods. How is ISPL working on this?

KS: We have developed a two-day training module. This has been done with the help of two distinguished experts who were faculty members of Indian Institute of Management, Ahmedabad Dr. D.M. Pestonji and late Prof. Anil Bhatt. Both liked the idea of developing training modules for grass roots level leaders which has modern management technique. The training module starts with a warming up session followed by role play to identify problems and its solutions, card game to identify strengths and weaknesses of individual participants followed by interaction on a video of success on different facets of development and how situations have been improved by local leaders themselves. These are all highly interactive sessions.

AS: I can see the large measure of interaction built into the format. The problems of rural migration are manifold. It is not just the people but also those with skills who leave behind an impoverished society. What are your prescriptions for this?

KS: Rural migration is a continuous affair. Main reason is some farmers find that agriculture does not provide sustainable livelihood due to recurrent crop failure or low yield due to untimely rain. Another reason now is the high price of land they are getting from land developers. The only solution is to make agriculture sustainable and for

Transformation of Dahod: a success story from School for Public Leadership (ISPL)

Prior to 1974

- Poorest district in the country
- Drought-prone area - with highly uncertain monsoon
- Tribal villages
- Migration every year after monsoon
- The irrigation coverage 10% on records, but in reality around 5%
- Agriculture yields poorest with predominance of maize crop
- Milk production lowest despite large cattle population
- Literacy rate very low
- Women literacy in one digit
- Undulating terrain with barren land with hardly any tree cover
- Most of its forest land without tree cover
- No horticulture, vegetable or floriculture
- High poverty.

In 2010

- Achieved food security
- Housing conditions improved
- School enrolment and attendance increased manifolds
- 68,000 ha of land under irrigation. 17,000 wells recharged.
- Irrigation coverage around 30 %
- 700 community water resources developed and managed by 325 village level irrigation cooperative societies.
- 2,700 village institutions and users groups managing their affairs and assets
- 65 rivers and rivulets made perennial through a series of structures connected to lift irrigation system.
- Migration rate 10-15 %
- Cropping pattern changed with introduction of horticulture – mangoes, floriculture, roses and vegetable crops.
- Six crore trees planted with 50 % survival at long run
- About 25,000 farmers opted for horticulture with average income of Rs.50,000 with continuous increase in income of poor families also.

that it has to be scientific and profitable. I quote how migration problem in Dahod was solved with convergence efforts initiated by Sadguru Development Foundation and Government departments. Local leadership was ignited from this most backward and remote district with difficult terrain and agro climatic conditions (See box).

AS: Your last assignment was in the State Agriculture Department. What would you rank as the most significant achievement during your tenure and why?

KS: I worked as a Principal Secretary in Agricultural Department. The most significant achievement was laying path for sustainable agriculture. This was done by re-structuring the Department and introducing a new Extension Model through Krushi Mahotsav. We organised pre-khariff extension at village level. Farmers were guided at their door steps. The extension teams along with agriculture scientists visited the village and guided the farmers, and answered their questions on person to person basis. This was backed by two significant actions: (i) Provision of quality seeds to poor farmers free of cost along with agricultural equipment limited to Rs.1,500. 15 farmers from every village provided this facility every year. The poor farmers normally use their own produce year after year which yielded low productivity. With certified/ quality seeds, this changed and there was direct improvement in productivity. (ii) The second important step was distribution of Soil Health Card which was based on soil health and moisture analysis. The farmers were given guidelines about crops which could be sustained on their soil, based on moisture and chemical composition of soil with appropriate nutrient and fertiliser use. Farmers were also given market price of the crops so that they could select best possible crops. This made agriculture sustainable in Gujarat coupled with measures related to water harvesting and linking of rivers.

Prosperity is visible due to innovative interventions in Dahod, a backward region of Gujarat

AS: You were the head of this important department. What prescription did you implement to make its functioning more responsive and less bureaucratic?

KS: The approach I have taken was to develop teams from the top at Secretariat level, Hon'ble Chief Minister and Chief Secretary to grass roots level; i.e., village level worker and Sarpanch and have direct dialogue with local level members of public governance system – like village accountant (Talati), local level elected leaders of Panchayati Raj system and cooperatives and involve all of them for betterment of poor farmers who constitute a majority.

AS: Enlightened scientists have been able to recover the waste and saline areas in the Rann of Kutch. How rigorous is the documentation so that lessons can be learnt for replicating this strategy in other regions?

KS: As discussed earlier, the documentation has been brought out as a book. This is being used by development planners in the country and outside.

AS: Planning Commission has recognised the experience and expertise of ISPL, Ahmedabad and NCCSD under your leadership. This is an acknowledgement and a huge responsibility. What do you read and how do you keep yourself abreast with developments in this rapidly changing scenario?

KS: We had an opportunity to give a presentation to Dr. Kasturirangan, Planning Commission and later to participate in interaction meet on "Agriculture Mission" chaired by Dr. Montek Singh Aluwalia. It was pleasant to realise that Planning Commission is conscious about these issues and keen on taking initiatives to motivate local level leaders to play important role in mitigating impact of global warming and for promoting sustainable livelihood and for use of successful experiences which already exists.

AS: How do you spend your free time? Are you fond of reading, listening to music or watching films?

KS: I am fond for reading, walking and yoga.

AS: One last question, Sir. How are you grooming the next generation of leaders in the movement who have the necessary commitment and competence?

KS: I am conscious that the next generation has very high levels of skills and commitment. We must give them opportunities to lead the development process.

Managing acute pancreatitis

Dr Yatish Agarwal
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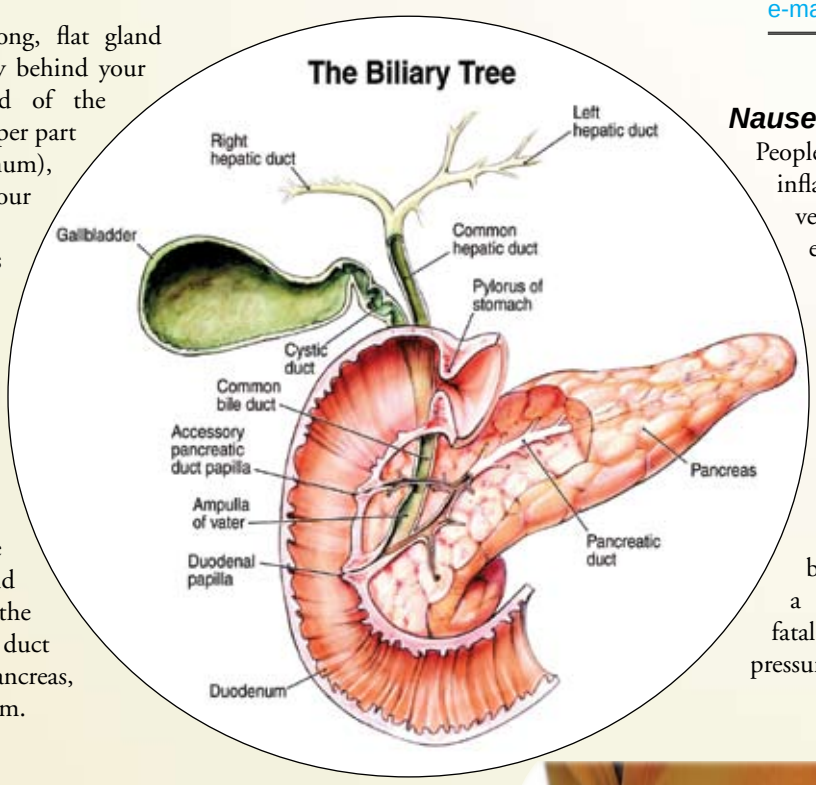
The pancreas is a long, flat gland that lies horizontally behind your stomach. The head of the pancreas rests against the upper part of the small intestine (duodenum), and its tail reaches toward your spleen.

The pancreas has two main functions in the body:



Exocrine function

The pancreas produces digestive juices and enzymes that help break down fats, carbohydrates and proteins. These pancreatic digestive juices and enzymes are transported to the duodenum through a small duct that courses through the pancreas, and opens into the duodenum.

Endocrine function

The pancreas also secretes the hormones insulin and glucagon into the bloodstream, along with somatostatin, another hormone that helps regulate their function. The primary role of insulin and glucagon is to regulate the metabolism of carbohydrates. The maintenance of steady blood sugar levels in the body relies on these hormones.

What is acute pancreatitis?

When inflammation develops in the pancreas, its functions get disrupted. The inflammation can be acute or chronic. Most cases are mild to moderate, but in about 20 per cent of people, symptoms can be severe.

Acute pancreatitis comes on suddenly, when digestive enzymes produced in the pancreas remain and activate in the pancreas, causing irritation and inflammation of the delicate pancreatic tissues. Each year, hundreds of thousands of people develop acute pancreatitis due to one or the other reason. The condition is serious and can be life-threatening if left untreated.

Key signs and symptoms

Acute pancreatitis causes a range of symptoms that occur suddenly and can be rather severe. These symptoms may include:

Spreading abdominal pain

The main symptom of acute pancreatitis is a severe upper abdominal pain that often bores through to your back. Lying flat causes your stomach to hurt even more, so to relieve the pain, you double over. Pain like this which may last for hours to days is typical of pancreatitis.

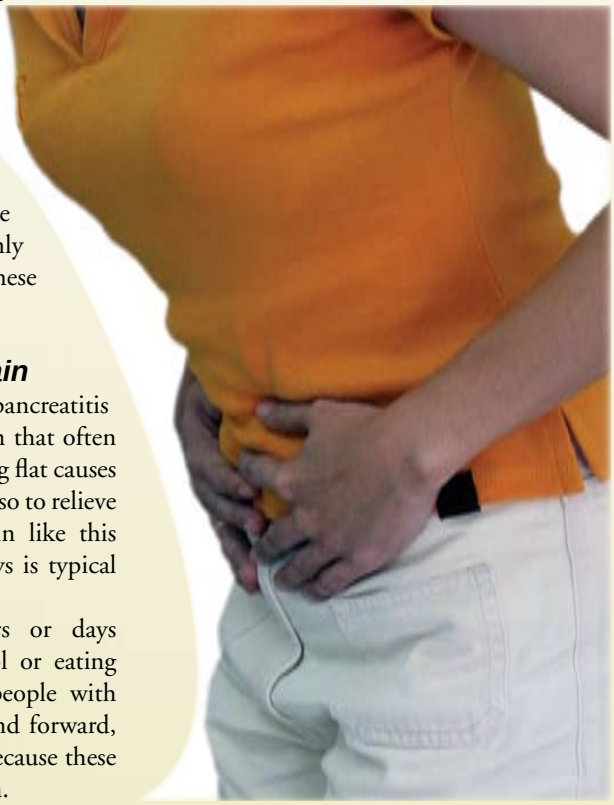
It can persist for hours or days without relief. Drinking alcohol or eating may worsen the pain. Many people with acute pancreatitis sit up and bend forward, or curl up in a foetal position, because these positions seem to relieve the pain.

Nausea and vomiting

People with severe pancreatic inflammation often feel and look very sick and they frequently experience nausea and vomiting.

Other symptoms

Other symptoms may include a high fever, difficulty in breathing, and abdominal bruises from internal bleeding. In severe cases, inflammation affects the whole abdomen, making it rigid and the pain becomes worse. There is also a risk of shock, a potentially fatal condition in which the blood pressure falls extremely low.

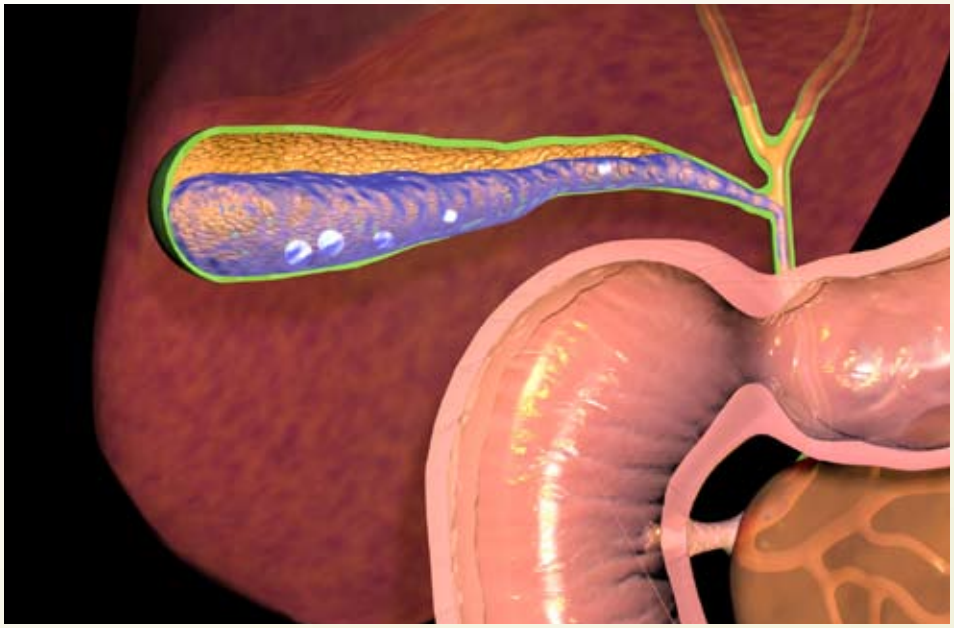


Two causes stand out

Pancreatitis can occur for various reasons, and in some cases its cause is unknown. The two most common known causes are gallstones and excessive alcohol use.

Gallstones

About half of people with acute pancreatitis have gallstones. Sometimes these stones will migrate out of the gallbladder through the common bile duct, which merges with the pancreatic duct near the entrance to the duodenum. At this junction, gallstones can lodge in or near the pancreatic duct and block the flow of pancreatic juices into the duodenum. Digestive enzymes become active in the pancreas instead of the digestive tract, causing severe inflammation of the pancreas (acute pancreatitis).



Alcohol

Excessive alcohol consumption over a long period can also cause an acute attack of pancreatitis. Between 5 per cent and 15 per cent of people who drink excessive amounts of alcohol get pancreatitis. Why some people get the disease but most don't is uncertain. It is also unclear how alcohol damages the pancreas. One theory is that excessive alcohol leads to "protein plugs" precursors to small stones that form in the pancreas and block parts of the pancreatic duct. Another theory is that alcohol directly injures pancreatic tissues. Typically, an attack of acute pancreatitis occurs 12–24 hours after a heavy bout of drinking.

Less common causes

Some other conditions may also lead to acute pancreatitis. These include:

- Calcium deposits or stones that can block the pancreatic or common bile duct
- Increased levels of triglycerides (blood fats) or of calcium in blood (hypercalcaemia)
- Structural abnormalities of the pancreas, abdominal trauma or major surgery
- Viral infection
- Certain medications such as immunosuppressants and thiazide diuretics (water pills)

Diagnosing pancreatitis

If your doctor suspects acute pancreatitis, he or she will check your abdomen for pain and tenderness.

Blood tests

A sample of your blood also may be analysed for abnormalities signalling acute inflammation:

- Elevated levels of the pancreatic enzymes amylase and lipase
- Elevated white blood cell count
- Elevated liver enzymes and bilirubin, a substance that results from breakdown of red blood cells
- High blood sugar (hyperglycaemia)
- Low calcium level (High calcium levels can cause pancreatitis, but low levels of calcium in blood, called hypocalcaemia, are the result.)

Ultrasound or computed tomography (CT) scan of your abdomen

Your doctor may request an ultrasound or computed tomography (CT) scan of your abdomen to examine the pancreas and look for gallstones, a duct problem or destruction of the gland. You also may have X-rays of your abdomen and chest to rule out other causes of your pain.

Complications of acute pancreatitis

About one-fourth of all cases of acute pancreatitis are severe and may lead to serious complications:

Infection

A damaged pancreas may become infected with bacteria that spread from the small intestine into the pancreas. Signs of infection include fever, an elevated white blood cell count and organ failure. A fluid sample from the pancreas may be tested for bacterial infection. If the tests are positive, the patient requires antibiotics. Some people also need surgery to drain or remove infected

areas of the pancreas. Sometimes, multiple operations are necessary.

Pseudocysts

Cyst-like blisters called pseudocysts may form on and extend from the pancreas after an attack of acute pancreatitis. If the cyst is small, no special treatment is necessary. If it is large, becomes infected or causes bleeding, intervention is necessary. Your doctor may drain the cyst through a catheter or you may need surgery to remove the cyst.

Abscess

This is a collection of pus near the pancreas that can develop 4 to 6 weeks after the onset of acute pancreatitis. Treatment involves drainage of the abscess by catheter or surgery.

The treatment

Severe acute pancreatitis usually requires a hospital stay under a surgeon's care. If you have complications, you may need continuous monitoring in an intensive care unit. Treatment centres on controlling the pain, allowing the pancreas to rest, and restoring a normal balance of pancreatic juices. Since the pancreas goes into action whenever you eat, you won't be able to eat or drink for a few days. Your stomach will be kept empty to prevent the pancreas from being stimulated to produce more digestive enzymes. A tube will be passed through your nose into your stomach to remove its contents by suction, and you will receive fluids and nutrition intravenously.

If your attack is caused by gallstones blocking the pancreatic duct, your doctor may recommend a procedure to remove the stones. You may eventually need surgery to remove the gallbladder once you have recovered from this acute attack. If alcohol is the cause, treatment may include therapy to stop drinking alcohol.

Mild cases of acute pancreatitis generally improve in 3 to 7 days, after which you may be able to eat and drink again. Moderate to severe cases take longer. In a few cases where the damaged pancreas becomes infected, it may need to be drained surgically. About 9 in 10 people survive an attack of acute pancreatitis, if they are able to receive the appropriate treatment. Severe pancreatitis carries a not-so-good prognosis, and may turn out to be life-threatening.

Continued from page 36 (Glenn Theodore Seaborg A Legend in the Annals of Discovery)

Philip Hauge Abelson

of Science. He was elected to a dozen of foreign national academies of science. He received over 50 honorary degrees from various universities. The number of awards received by Seaborg can be judged by the fact that his name found place in the *Guiness Book of World Records* for having the longest entry in "Who's Who in America". Seaborg himself considered naming an element (element 106 as seaborgium) in his honour while he was still living as his greatest honour and he said: "This is the greatest honor ever bestowed upon me—even better, I think, than winning the Nobel Prize."It is often said that seaborgium is the only element to be named after a living person but it may not be considered an accurate information. Two elements were proposed to be named 'einsteinium' and 'fermium' after Albert Einstein and Enrico Fermi when both of them were alive but because of nuclear secrecy rules these names were not made public. The public or the broader scientific community came to know about these elements and their names only after the death of Einstein and Fermi.

Seaborg died on 25 February 1999 in Lafayette, California at the age of 86. Once on being asked what advice he would give the students he said: "If I could tell students anything, it would be two words 'Work hard,'. This is perhaps the greatest lesson a student can learn from a teacher. Throughout his life Seaborg shared his enthusiasm for discovery with others, particularly with his students and colleagues. Room 307 of the Gilman Hall in the University of California, where Seaborg did most of his work on transuranium elements, has been declared a US National Historic Landmark. An autobiography written with his son Eric Seaborg, Adventures in *Atomic Age: From Watts to Washington* was published in 2001.

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(The article is a popular presentation of the important points of the life and work of Glenn Theodore Seaborg available in the literature. The idea is to inspire the younger generation to know more about Seaborg. The author has given the sources consulted for writing this article. However, the sources on the Internet are numerous and have not been individually listed. The author is grateful to all those authors whose works have contributed to writing this article and the sources of the pictures reproduced here.)

Recent developments in science and technology

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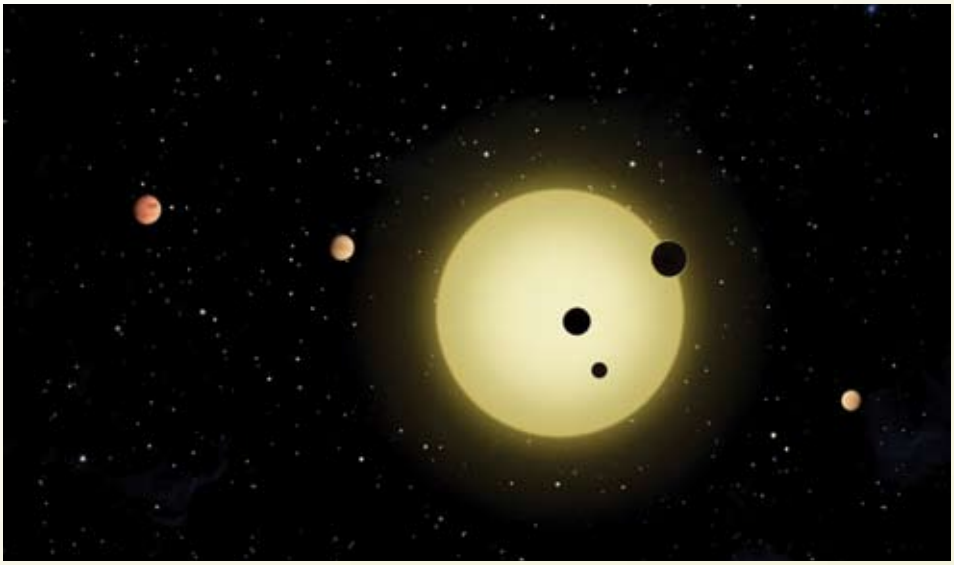
Kepler discovers six-Earth-like exoplanets

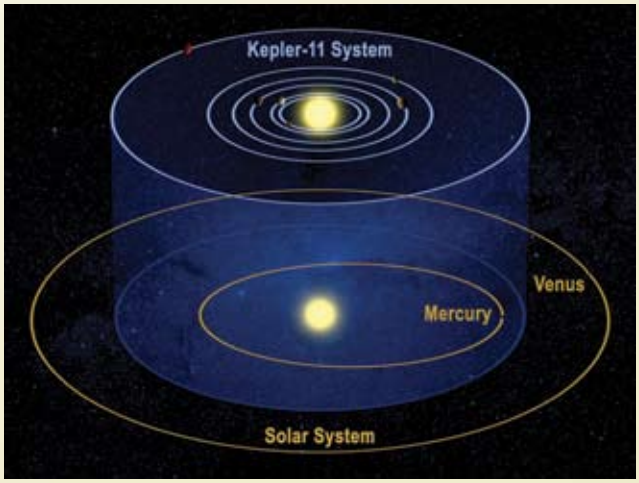
The discovery of the first Earth-sized planets made of a mix of rock and gases around a Sun-like star, by NASA's *Kepler* mission was announced in February (*Nature*, 3 February 2011). The planets were discovered in the 'habitable zone' around the star – a region where liquid water could exist on a planet's surface. Of the six planets one is 0.9 times the radius of the Earth, and four of them are less than two Earth radii. Any of those would be the most Earth-like world ever detected outside the solar system. The researchers describe them as being relatively "puffy", having fairly large radii for their masses. They suggest that the planets probably lie somewhere between the densities of Earth and Neptune, and the inner two planets may well be made from rock and water with a steam atmosphere, being very close to the star.



An artist's depiction of Kepler-11, a Sun-like star with six planets orbiting on the same plane. (Credit: Reuters)

The discovery has been hailed as the biggest discovery in the field since the first exoplanet was discovered in 1995. With the new findings the total number of planets identified by *Kepler* to date has gone up to 1,235, circling 997 host stars. Of these, 68 are approximately Earth-sized; 288 are super Earth-sized; 662 are Neptune-sized; 165 are the size of Jupiter; and 19 are larger than Jupiter.

The Sun-like star, named Kepler-11, around which the six planets were discovered, lies at a distance of over 2,000 light years from Earth. The planets were discovered by the transit method, in which a slight dimming in the light of a star, as a planet sweeps across our line of vision from Earth, is detected and measured by a photometer. The recent findings are based on the results of observations conducted between 12 May and 17 September 2009, of more than 156,000 stars in *Kepler's* field of view, which covers approximately 1/400th of the sky. The star field that *Kepler* observes lies in the constellations of Cygnus and Lyra.



This artist's conception shows the Kepler-11 planetary system and our solar system to demonstrate that the orbits of each lie on similar planes. (Credit: NASA/Tim Pyle)

Since transits of planets in the habitable zone of Sun-like stars occur only about once a year and require three transits for verification, it usually takes three years to locate and verify Earth-size planets orbiting Sun-like stars, as was done in the present case. Prior to this finding, only one star was known to have more than one orbiting planet – Kepler-9, discovered last year, which has two confirmed planets and possibly a third.

The *Kepler* spacecraft is a NASA space observatory specially designed to discover Earth-like planets orbiting other stars. Named in honour of German astronomer Johannes Kepler, the spacecraft was launched on 7 March 2009, with a planned mission lifetime of at least 3.5 years. *Kepler* carries a photometer – an instrument for measuring the intensity of light – developed by NASA to continuously monitor the brightness of over 145,000 stars in a fixed field of view. From the analysis of the data collected from these observations periodic fluctuations in intensity can be detected to show the presence of planets around distant stars.

According to the *Kepler* science team, "the six planets are mixtures of rock and gases, possibly including water. The rocky material accounts for most of the planets' mass, while the gas takes up most of their volume." By measuring the sizes and masses of the five inner planets, the scientists were able to determine that they are among the planets with the lowest mass beyond our solar system.

Fungus to fight malaria

A tiny fungus called *Metarhizium anisopliae* could become the next weapon to fight malaria, which kills more than 200,000 people in India every year. This fungus naturally infects mosquitoes but, unlike pesticides, takes days to kill them, which cannot be quite effective in malaria control. A team of American and British researchers have now engineered transgenic fungi that can bore into mosquitoes and kill the malaria parasite inside – the first tool of its kind. Historically the only way to control malaria was by killing the mosquitoes with insecticides because the parasite that causes malaria, *Plasmodium falciparum*, is transmitted by the female Anopheles mosquito. But this approach has caused the rapid evolution of insecticide-resistant mosquitoes, lessening the effects of current control tactics. When used in conjunction with traditional use of insecticides against mosquitoes, experts say this bioinsecticide has the potential to greatly improve malaria eradication efforts.

To make the fungus act faster, researcher Raymond St. Leger and his colleagues added a few new genes to the fungal DNA, turning *M. anisopliae* into a drug-producing factory. The engineered fungus is able to drill through the insect's cuticle and express any of three different genes that could potentially control the transmission of the malaria parasite: a gene that blocks the parasite's access to the mosquito's saliva, where it could be passed on to its next blood meal; a human anti-malaria antibody; and an antimicrobial from scorpion venom. Interestingly, these genes are only activated once the fungus hits the haemolymph – the blood equivalent of the mosquito, in which the malaria parasite circulates. According to the researchers, the chemicals are bad for malaria parasites but do not do any extra harm to mosquitoes (*Science*, 24 February 2011).

According to the researchers, individually, these genes reduced *Plasmodium* sporozoite counts by 71, 85 and 90 percent, respectively, when sprayed onto mosquitoes with advanced malarial infections (11 days after feeding on parasite-infected blood). When the gene that blocked the saliva glands were combined with scorpion antimicrobial, an astounding 98 percent of sporozoites were eliminated. Notably, the fungus *M. Anisopliae* has no effect on humans and that means it could be safely released in large-scale malaria control efforts. Morover, because the fungus is slow-acting, the mosquitoes are not likely to quickly evolve resistance against its attack.

Unfortunately, putting the new technique into action may not be an easy task because genetic engineering involves a suite of regulatory issues and inevitably public critics. Moreover, only rigorous testing will show whether the modified fungi work under real-world conditions. So, even though this discovery is extremely exciting, it may be still a long way from being a tool in the field.

A genetically modified fungus can kill the malaria parasite in the body of the Anopheles mosquito.

Dumped drugs lead to resistant microbes

The high and sometimes inappropriate use of antibiotics has accelerated the development of antibiotic resistance, creating a major challenge for the sustainable treatment of infections world-wide. Apart from indiscriminate use for treating minor infections in humans, dumping of antibiotic drugs in water bodies has been found to be a major cause of development of drug-resistant microbes. Recently a team of scientists from Sweden led by Joakim Larsson of the University of Gothenburg, Sweden, reported the presence of high levels of antibiotic drugs in river water near a waste-water treatment plant in Patancheru near Hyderabad in Andhra Pradesh. According to the researchers, the treatment plant released drugs in its effluent water at levels sometimes equivalent to the high doses that are given therapeutically. The antibiotic-containing water reaching the plant came from 90 bulk pharmaceutical manufacturers in the region, the researchers found. When the researchers tried to find out what might be happening to bacteria in the environment exposed to these drugs, they found evidence of resistance genes in bacteria found in the contaminated water.

Bacteria can exchange bundles of drug-resistance genes present in small circles of DNA called plasmids, which can replicate themselves independently of the bacterium's chromosome. To find these bits of DNA, Larsson and his colleagues used a DNA sequencing approach called "shotgun metagenomics," to analyse all the DNA present in the effluent, the river water, and the river sediments. A bioinformatics method was also developed to analyse the information and search for evidence of known antibiotic-resistance genes.

The researchers found that in three sites downstream of the plant, the resistance genes made up almost two percent of the DNA samples taken there (*PLoS ONE*, February 2011). Since only one or two genes out of the typical genome of around 5,000 genes are necessary to protect the bacterium, the degree of genetic resistance found by the researchers was quite substantial.

Surprisingly, the researchers found resistance genes for a wide range of antibiotics, but in many cases there was no direct relationship to the antibiotics present. For example, the most frequent resistance genes found were for a class of antibiotics called sulphonamides, but the researchers found no evidence of the drugs themselves in the water. They hypothesise that this may be an instance where resistance to one group of drugs could provide resistance to others. On the other hand, despite detecting high concentrations of fluoroquinolones, a chemical group that includes the antibiotic ciprofloxacin, the team found less evidence

of resistance to these drugs downstream than upstream from the plant.

According to some scientists who specialise in infectious diseases, the spread of antibiotic-resistance genes is complicated. They say resistance hotspots like the one at Patancheru could end up behaving like a volcanic eruption. Resistance genes may appear somewhere else, not just around the sewage plant. Also, resistance genes already present in bacteria from human waste, or developed by the bacteria used in the plant's treatment stages to break down the sludge, could be swept along with the effluent into the river. Therefore there is need to consider the entire life-cycle of antibiotic substances, both before, under, and after usage, to fully evaluate their role in the promotion of resistance.

Global warming increase heavy rain floods

The rise in extreme weather conditions in recent years has been taking a heavy toll of life and property around the world. The devastating floods in Australia, Brazil, Pakistan, and Sri Lanka are recent examples. Floods in Queensland, Australia have ravaged an area the size of France and Germany combined. On the other side of the globe, in the mountains of southeast Brazil, more than 340 people have died after fierce mudslides swept away homes following heavy rains. A new study directly links rising greenhouse-gas levels – now roughly 390 parts per million, up from 280 ppm in the 1700s – with the growing intensity of rain and snow in the Northern Hemisphere, and the increased risk of flooding in many parts of the world (*Nature*, 17 February 2011).

Warmer atmospheric air means more water vapour, which is itself a greenhouse gas, which makes the problem worse. What goes up must come down and, in this case, more and more of the water vapour that goes up is coming down in extreme precipitation events, causing widespread floods. Climatologist Francis Zwiers of the University of Victoria in British Columbia and colleagues at Environment Canada examined daily records of rainfall, snowfall and other precipitation stretching from 1951 to 1999 from more than 6,000 weather stations around the globe. In each year of that period, they determined how extreme precipitation had been. By compiling the information from all these years and comparing it with the precipitation patterns predicted by computer models of the climate, the scientists noted a similar pattern emerging in the real-world data. Significantly, the researchers could not explain this pattern by natural climate fluctuations. They suggested that human-induced climate change is the culprit behind the increase in downpours and blizzards in the last 50 years of the 20th century – at least in the Northern Hemisphere.

The study demonstrates for the first time the human influence on the climate and also on the water cycle, and outside the bounds of typical physical responses such as warming of deep ocean and sea surface temperatures, or diminishing sea ice and snow cover extent.

Increasing severity and frequency of heavy rain and floods can be attributed to global warming caused by human activity.

In order to attribute any specific extreme weather event – such as the downpours that caused flooding in Pakistan or Australia, for example – requires running such computer models thousands of times to detect any possible human impact amidst all the natural influences on a given day's weather. So, the research team also called on tens of thousands of volunteers who ran a climate model thousands of times on their personal computers in the background as part of the climateprediction.net Web site. After six years of running such simulations, it was found that the increasing greenhouse gas concentrations as a result of burning fossil fuels and cutting down forests indeed increased the risks of flooding in two out of three model runs by more than 90 percent.

Your opinion

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

This month's topic:

"After the recent earthquake and tsunami in Japan that caused serious damage to three nuclear power plants, do you consider nuclear energy a safe option for generating electricity to counter global warming?"

Response should contain full name; postal address with pincode and email ID, if any; and should be accompanied by a recent passport size photograph. Response may be sent by email (opinion@vigyanprasar.gov.in) or by post to the address given below. If sent by post, "Response: *Dream 2047* April 2011" should be clearly written on the envelope.

Vigyan Prasar
A-50, Institutional Area, Sector-62, Noida 201 307 (U.P.)
Phone: 91-120-240 4430/35 Fax: 91-120-240 4437
Email: info@vigyanprasar.gov.in Website: www.vigyanprasar.gov.in

Winners of "Your Opinion" contest for January 2011

Topic: "Will it be possible to control global warming in the next 50 years?"

Sarabjeet Kaur
#1081, sector 56, Chandigarh.
PIN: 160055

Nature has provided an excellent blanket on Earth from icy cold space with right amount of greenhouse gases that has kept it about 33 Celsius warmer than it would be without it. But with increasing amounts of greenhouse gases, anthropogenic global warming has rung alarms of danger. It has posed danger for next generation in the form of severe floods and drought, increasing prevalence of insects and deadly diseases, rise in sea level due to melting of arctic glaciers. After 1997 Kyoto protocol, under which 37 countries committed themselves to reduction in greenhouse gases emission, global warming became a world concern. It was followed by other agreements that focused on solving this problem .But still a lot needs to be done to get fruitful results in the next 50 years. Efforts at individual level such as using public transport and renewable sources of energy, cutting gross carbon emission by using less electricity, smart electrical appliances, CFL bulbs, etc, and following the 3 R's: Reduce, Reuse and Recycle. Planting of trees and plants on a large scale can have significant impact on reducing greenhouse gas level in the atmosphere. It is not just the responsibility of environmental organisations or governments but also each individual to stand together to solve this problem for a better future.

*****

Mahendra Singh
PGT (Physics)
KV No 1, AFS, Jodhpur
Jodhpur (Rajasthan)
Pin-342001

Global warming is a phrase that is used to describe the unusually rapid increase in Earth's average surface temperature over the past century. This rise in temperature is attributed to an increase in greenhouse gases – carbon dioxide, methane and nitrous oxide – in the atmosphere. . Greenhouse gases are produced mainly by burning of fossil fuels such as coal, oil, and gas by industry, in homes, and in transport vehicles. Global warming is a grave issue that is affecting not only one region or one country, but the world as a whole. It may be possible to control global warming in next 50 years only if we can reduce our dependence on fossil fuels and go for renewable, non-conventional and nuclear energy sources. Evolution of high efficiency CFL for lighting is a major step forward. Solar photovoltaic technology, Fuel cells, improved batteries, second generation biofuels, etc., are some of the technologies which have the potential to reduce energy consumption leading to lowering of carbon footprint. Carbon capture and storage is another promising technology as far as controlling global warming is concerned.

*****

Ekansh Goel, 8th-B
Police DAV Public School, Jalandhar cantt.
EF-2 Mandi Road,
Jalandhar City,
Punjab – 144 001

The biggest problem is of global warming is basically due to increasing amounts of carbon dioxide and other greenhouse gases. The problem of global warming can be tackled through the use of renewable energy resources like solar energy, wind energy, tidal energy, and geothermal energy. But problem arises from their initial cost. For example, to extract energy from the Sun rays we have to use photovoltaic cells which are costly to produce because the raw material used to make them is pure silicon. So we have to explore more so that we can make it cheaper and everybody could install it in their homes. It would be possible to tackle global warming in next 50 years only if each of us act together to reduce consumption of energy in any form.

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Regional workshop on Innovative Experiments in Physics

Based on the module developed by Vigyan Prasar and IIT, Kanpur as a collaborative programme to train Master Resource Persons, Vigyan Prasar has planned five regional workshops on Innovative Experiments in Physics. The second four-day workshop was organised for the Western Zone at Nehru Science Centre, Mumbai, from 31 January to 3 February 2011. Fifty-two teachers and science communicators attended the workshop. The participants of this workshop were selected out of 350 nominations received by VP. The nominations were invited through Dream-2047, VIPNET News and Vigyan Prasar website.

Workshop in progress

Er Anuj Sinha interacting with the participants

The workshop was inaugurated by Shri Anil Manekar, Director, National Science Centre. Professor Dipan K. Ghosh, Department of Physics, IIT, Bombay was the chief guest at the inaugural function. Shri Rintu Nath, Scientist, and Shri B. K. Tyagi, Scientist represented Vigyan Prasar.

Shri Rintu Nath and Dr. Ajay Mahajan conducted the workshop and demonstrated 120 innovative activities/experiments during the four-day workshop. Participants did hands-on activities during the workshop. Each participant assembled one kit. Using the kit about 20 activities can be performed. A CD on 'Innovative Experiments in Physics' and a kit 'Emergence of Modern Physics' developed by VP was given to all the participants.

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

During the workshop, National Science Centre also demonstrated a number of activities related to physics. A 3D film show and night sky watching was organised for all the participants. A series of interactive sessions was organised by Shri B. K. Tyagi on programmes and activities of VP and how science clubs could be formed to initiate activities.

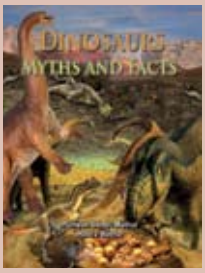
Participants doing hands-on activities

Er Anuj Sinha, Director, Vigyan Prasar, interacted with the participants on the last day of the workshop. He mentioned that manpower trained by VP in different workshops should be a part of VP initiatives in science communication and each participant may start working in their respective areas. The participants demonstrated innovative activities developed by them. Many participants were of the view that hands-on activities/experiments help in understanding the concepts better and make the subject interesting. All the participants were given certificates of participation by Er. Anuj Sinha.

The third workshop was organised for the Southern States at Sri Venkateswara University, Tirupati from 7 to 10 February 2011. Forty-six participants representing Kerala, Andhra Pradesh, Tamil Nadu, Pudducherry, and Karnataka attended the workshop. The workshop was inaugurated by Prof. Prabhakar Rao, Vice Chancellor of SVU.

During the 4-day workshop, about 130 experiments were demonstrated on topics like optics, magnetism and electricity, etc. A kit comprising of about 35 items was also assembled and given to each participant. A Valedictory Function was organised in Department of Physics, which was presided over by Prof. Buddudu, Head of Department of Physics, S V University.

Vigyan Prasar Publications

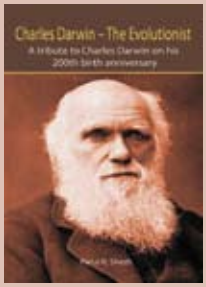


Dinosaurs: Myths and Facts

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

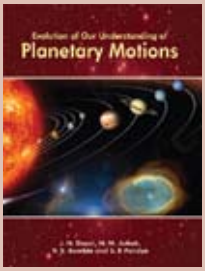
This book answers practically all the question on the dinosaur myths and facts. The illustrated book tells a great deal about the wonderful recent finds of Indian dinosaurs skeletons, eggs, footprints, dungs etc. which are some of the best in the world; and evidences in India about extinction of dinosaurs.

Charles Darwin: An Evolutionist



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

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

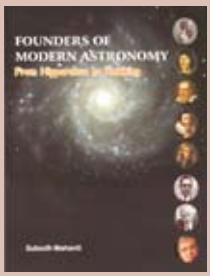


Evolution of Our Understanding of the Planetary Motions

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

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

Founders of Modern Astronomy: From Hipparchus to Hawking



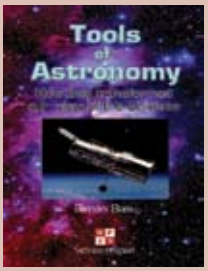
Subodh Mahanti
ISBN: 978-81-7480-200-2
pp : 326 • Price: ₹ 200

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

Heretic to Hero: Galileo Galilei-Rebel Astronomer

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

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

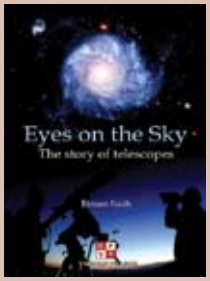


Tools of Astronomy

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

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

Eyes on the Sky: The Story of Telescopes



Biman Nath
ISBN:978-81-7480-196-8
pp : 172 • Price: ₹ 140

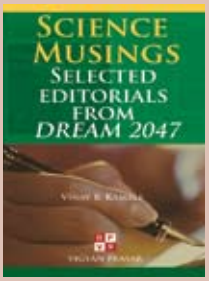
This book chronicles the history of telescopes in easy language and with many illustrations.

Story of Chemistry

Anirban Hazra
ISBN: 81-7480-135-9
pp: 115 • Price: ₹ 75

This book traces the development of Chemistry, the science of matter, from its origins in antiquity to the modern and quickly evolving sceince that it is today.

Science Musings: Selected editorials from DREAM 2047



Vinay B. Kamble
ISBN:978-81-7480-203-3 (HB)
pp : 361 • Price: ₹ 200

This book is a compilation of the selected editorials written by Dr. Vinay B. Kamble, former editor of the popular science monthly magazine Dream 2047 of Vigyan Prasar, over the period 2000-2009.

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