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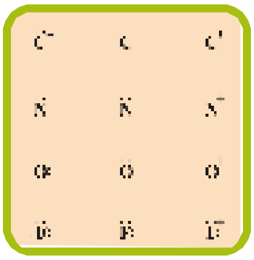

Editorial

In the first fortnight of October every year, the scientific community eagerly awaits the announcement of Nobel Awards, the symbol of highest recognition, a scientist aspires to receive for her/his work in basic sciences. Instituted in 1901 as per the will of Alfred Nobel, the Nobel Awards are conferred on those who have done their best to serve mankind in the field of Physics, Chemistry, Medicine, Literature and Peace. "Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel" has been added since 1969 though technically it is not a Nobel award but its announcements and presentations are made along with it. The Nobel awards for Physics and Chemistry are announced by the Swedish Academy of Science. The Nobel Prize in Physics for the year 2009 has been shared by three scientists– Charles K. Kao, Willard S. Boyle, and George E. Smith. Charles K. Kao receives the award for his "groundbreaking achievements concerning the transmission of light in fibres for optical communication" while Makoto Kobayashi and Toshihide Maskawa were nominated for the "invention of an imaging semiconductor circuit – the CCD sensor". Nobel Prize in Chemistry has been awarded by the Swedish Academy of Science to Venkatraman Ramakrishnan, Thomas A. Steitz, and Ada E. Yonath for enlightening the science community on the 'structure and function of the ribosome'. Nobel Prize for Physiology and Medicine is to be shared by three scientists– Elizabeth H. Blackburn, Carol W. Greider, and Jack W. Szostak for their discovery "how chromosomes are protected by telomeres and the telomerase enzyme". The lead article of this issue attempts to highlight the work of these Nobel laureates and its significance for future developments. This year's announcement for the Nobel Prize in chemistry had special significance for Indians as also our education system, as one of the awardees, Venkatraman Ramakrishnan, happens to be an Indian American. Venkatraman Ramakrishnan is the third Indian American, after Hargobind Khorana and S. Chandrasekhar, who has been bestowed with this honour. Venkatraman Ramakrishnan has been a brilliant student right from his school days. In fact, as a student of the then higher secondary stage (Class XI) in 1968, he was selected for award of scholarship under National Science Talent Search Scheme (NSTS) instituted by the NCERT in 1963 for nurturance of talent in science.

It has been our endeavour to keep our patrons abreast with recent developments in basic sciences and upcoming technologies through articles,features and science news. In the last few years, an attempt has been made through the articles and science news through the pages of this journal to highlight important developments in the field of nanotechnology. An article presenting a design of a curriculum to introduce nanotechnology as a subject of study at the higher secondary stage has been included in this issue. It is envisaged that educationists, especially curriculum developers, would ponder over the implications in the event such a futuristic technology is accepted at school stage. Holography is another technology, which in recent past have become quite common, particularly as a potent tool to protect copy right infringements. To have a three dimensional view of a picture with a holograph is always a fascinating experience. Students often wonder how holographs are produced and what the scientific principle behind it is. It is envisaged that the article on this subject would facilitate understanding the basic principles of holography.

Studies on various aspects of science education besides providing us ideas for improving quality of teaching science in schools, also give us an in-depth understanding about issues and problems that need be addressed. In recent times 'episodic conceptualisation' has been identified as one of the origins of pupils' alternative conceptions. It is hypothesised that the episodic format of the form, content, and mode of presentation of two interrelated concepts, say kinetic energy and work, is likely to generate two isolated, mutually independent cognitive structures amongst learners often emanating from the manner these are presented in the textbook and by the teachers in the classroom. The research design, methodology and outcome of a study on episodic conceptualisation and its implications form the basis of another article in this issue. Children's concepts on some aspects of environment, application of computers in teaching learning of science, theory of metacognition and its role in learning and teaching are some other issues on which articles find a place in this number, in addition to regular features like the 'Science News', 'Web Watch' and 'You've Asked'.

We sincerely hope that our readers would find the articles, features and news items interesting and educative. Your valuable suggestions, observations and comments are always a source of inspiration and guide us to bring further improvement in the quality of the journal.

NOBEL PRIZE IN SCIENCES–2009

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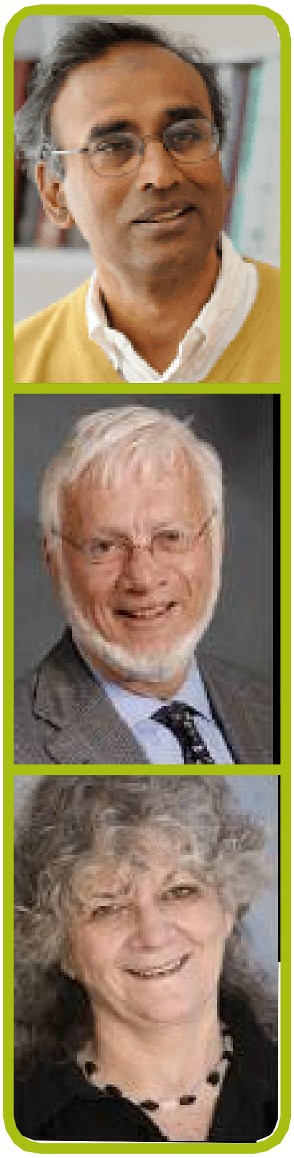
The prestigious Nobel award, instituted at the behest of the great scientist and the inventor of dynamite 'Alfred Nobel,' is tribute to persons who render most valuable service to humanity by their resolute and concerted work in different fields of physics, chemistry, physiology and medicine, economics and peace. The award is more than a mere symbol of recognition. The prize money of 1,66,000 US dollars is also of substantial help to individual scientists to carry forward research in their field of interest to satisfy their insatiable desire, in knowing the unknown for the benefit of mankind for which they have devoted their lives and effort. The Nobel Prize is an international award administered by the Nobel Foundation in Stockholm, Sweden.

Like every year, the Nobel Prize for physics and chemistry for the year 2009 were announced by the Swedish Academy of Science while The Stockholm Faculty of Medicine recommended the awards for physiology and medicine.

Nobel Prize in Chemistry

This year's Nobel Prize in Chemistry has been awarded to three scientists: Venkatraman Ramakrishnan, Thomas A. Steitz, and Ada E. Yonath for enlightening the science community on the 'structure and function of the ribosome'. Out of the three big molecules for life (DNA, RNA, and Proteins), proteins arguably take lion's share of the work. Proteins provide structural stability to the cells, give mechanical motion to muscles, transport oxygen and play many other key role in nearly every chemical reaction that occurs in the cells. The three Nobel awardees, Ramakrishnan, Steitz, and Yonath, used- X-ray crystallography to identify and map the positions of the atoms in the ribosome to provide its 3-D models to scientists to facilitate further studies and dissect them for crucial information at the atomic level. This was a unique achievement as there are hundreds of thousands of atoms involved. Their work has benefited many other areas of research, including the study of antibiotics. As synthesis of proteins is essential for the survival of bacteria, the ribosome is a practical target for drugs. The researches carried out by Nobel laurates have provided vital information for the design of new antibiotics. The three-dimensional model (3-D), developed by the three scientists showed how different antibiotics bind to ribosomes. These models are now used by scientists in order to develop new antibiotics, directly assisting the saving of lives and decreasing humanity's suffering.



Venkatraman Ramakrishnan

Thomas A. Steitz

Ada E. Yonath

Fig. 1 : Nobel Prize awardees in Chemistry

Venkatraman Ramakrishnan, born in 1952 in Tamil Nadu, India, did his Ph.D from University of Ohio in 1976. He is a senior scientist and now leads a strong research group at the Medical Research Council (MRC) Laboratory of Molecular Biology in Cambridge, UK. He has determined the structure of the *Thermus thermophilus's* (heat-stable bacterium) 30S ribosomal subunit in complex with several antibiotics. Dr Ramakrishnan's research into the ribosome and its complexes with antibiotics, initiation factor 1 (IF1), as well as cognate and near-cognate tRNA has resulted in an extensive body of publications.

Thomas A. Steitz, born in 1940 in Milwaukee, WI, did his Ph.D from Harvard University in 1966. He is now Sterling Professor of Molecular Biophysics and Biochemistry, and an investigator of the Howard Hughes Medical Institute. His scientific career has been focused on studying the structural basis of the molecular and chemical mechanisms by which proteins and nucleic acids execute their biological functions. Dr Steitz's imaged the first high-resolution crystal structure of the large ribosomal subunit known as 50s from *Haloarcula marismortui* with a resolution of 9 Å.

Ada E. Yonath, born in 1939 in Jerusalem, Israel, did her Ph.D in X-ray Crystallography from Weizmann Institute, Israel in 1968. She is presently the Director of the Kimmelman Centre for Biomolecular Assemblies at the Weizmann Institute of Science in Rehovot, Israel. The ribosome was central to her research from the initial crystallisation studies in the late 1970s to her first electron density map of the small ribosomal subunit from *Thermus thermophilus*, constructed at 4.5 Å.

Yonath and Ramakrishnan obtained the structure of the small subunit (30S) from *Thermus thermophilus*. Thus, it was possible to map ribosome functionality at the most basic, atomic level.

Their research showed how the ribosome looks like and how it functions at the atomic level. They have used a method called X-ray crystallography to map the position of every one of the hundreds of thousands of atoms that make up the ribosome. This method determines the three dimensional structure of molecules which are organised in different pattern in the crystals. These molecules within the crystal diffract the X-rays in specific directions when these are exposed to a beam of X-rays. By studying the diffraction pattern, the intensities and position of the diffracted beam, crystallographers can identify the position and atomic details of the molecules.

By building a (3-D) structure of the ribosome using X-ray crystallography method, they solved an important part of the problem posed by Francis Crick and James Watson, when they proposed the twisted double helical structure of DNA, i.e. how does genetic code become a living thing? DNA is made available to the ribosome by "transcription" of genes into chunks of messenger RNA (mRNA). In the ribosome, these mRNA are translated into various amino acid sequences by the method of translation and make up an organism's proteins. The work is based on a technique called X-ray crystallography, where protein molecules are removed from cells, purified and made into crystals that can be examined by X-rays.

Every cell of the organism have DNA molecules in their nucleus. They contain the blueprints for how an organism, say a human being, a plant or a bacterium, looks and functions. These blueprints get transformed into living matter through the function of ribosomes. Based upon the information coded in DNA, proteins are formed in ribosomes. There are tens of thousands of proteins in the body of an organism and they have different structures and functions. They build and control life at the chemical level.

Ribosomes were first discovered in the mid 1950s by a cell biologist George Palade using electron microscope and the term 'ribosome' for them was proposed by Biologist Richard B.

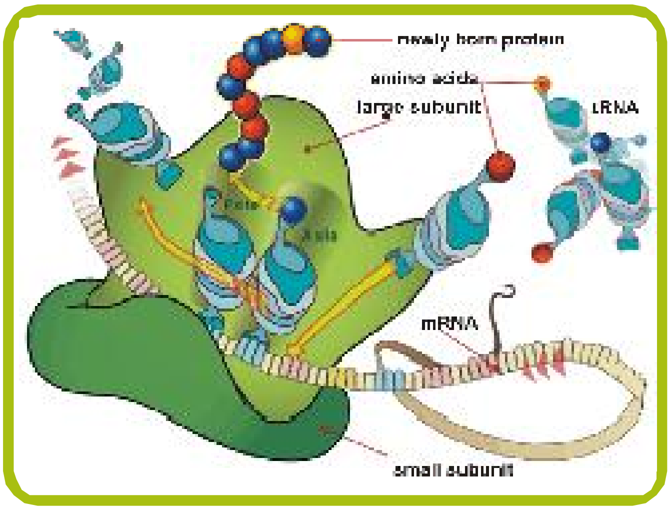


Fig. 2: Translation Process (the synthesis of protein)

(Source : http://www.ortodoxiatinerilor.ro/2008/09/genele-sinteza-proteinelor-codul-genetic-5)

Roberts. An understanding of structure and function of the ribosome is important for a scientific understanding of life. Ribosome is the part of cellular components that make the protein. It is
20 nm in diametre and is made up of a complex comprising 65 per cent RNA and 35 per cent Protein. Ribosomes are divided into two sub-units: larger and smaller. The unit of measurement of sub-unit is Svedberg unit (s), a measure of the rate of sedimentation in centrifugation. The ribosome is the site of protein synthesis (protein factory) in a living cell. The ribosome translates genetic code into proteins, which are the building blocks of all living organisms. The sub-unit of ribosome in prokaryotes and eukaryotes are different, the prokaryotes have 70S ribosome made up of larger sub-unit of 50S and smaller sub-unit of 30S. Eukaryotes have 80S ribosome, it has larger sub-unit of 60S and smaller sub-unit of 40S. These sub-units play an important role in translation, a process for the synthesis of protein. The three nucleotide genetic codon bind to these sub-unit with the help of tRNA and make the protein in this process.

Human and bacterial ribosomes are slightly different, making the ribosome a good target for antibiotic therapy that works by blocking the bacterium's ability to make the proteins it needs to function. Nowadays, various antibiotics are in use that cure diseases by blocking the function of bacterial metabolic activity in the translation process (protein synthesis). Dr Ramakrishnan discovered the function of these ribosomal sub-units complex with various antibiotics. He also determined that how antibiotics bind to specific pockets in the ribosome structure. The antibiotics cure the disease by interfering in the function of bacterial (infecting) ribosomes by preventing them to make the proteins they need to survive. As making proteins is essential for the survival of bacteria, ribosome in them is the main target of antibiotics, which stops the protein synthesis. Without functional ribosomes, bacteria cannot survive because of its inability to synthesise protein. This is why ribosome is such an important target for new antibiotics. This research could help scientists to design antibiotics to treat people who are infected with a bacterium that has developed resistance against traditional antibiotics. Better targeting of the bacterial ribosome should also help to avoid negative effects on human cells thereby reducing the side effects of taking antibiotics. Biologists in pharmaceutical and biotechnology companies will also use this valuable information to develop new antibiotics to fight the growing problem of bacterial drug resistance.

Nobel Prize in Physics

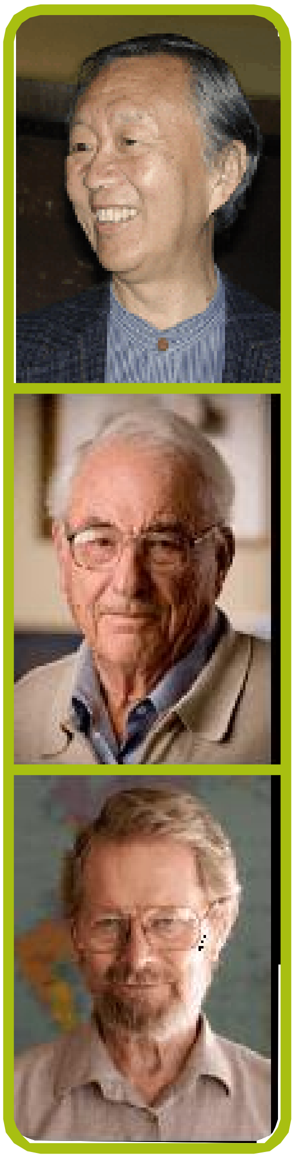
The Nobel Prize in Physics–2009 has been awarded jointly to three Scientists– Charles K. Kao, Willard S. Boyle, and George E. Smith. This year's Nobel Prize in Physics is awarded for two scientific achievements that have helped to shape the foundations of today's networked societies. Charles K. Kao received the award for his "groundbreaking achievements concerning the transmission of light in fibres for optical communication" while Makoto Kobayashi and Toshihide Maskawa were nominated for the "invention of an imaging semiconductor circuit – the CCD sensor ".

Charles K Kao, born in 1933 in Shanghai, China, is also known as Father of Modern Communications. He did his Ph.D from University of London in 1965. He is retired Director of Engineering at Standard Telecommunication Laboratories, Harlow, UK and Vice-Chancellor at Chinese University of Hong Kong. He was cited for his 1966 discovery that showed how to transmit light over long distances via fibre-optic cables, which became the backbone of modern communication networks that carry phone calls and high-speed Internet data around the world.

Willard S. Boyle, born in 1924 in Nova Scotia, Canada, did his Ph.D from McGill University in 1950. He was Executive Director of Communication Sciences Division, Bell Laboratories, Murray Hill, New Jersey, USA. In 1962, he worked with Dr Nelson and invented the first continuously operating ruby laser; he was appointed as director of Bellcomm's (a Bell Labs subsidiary) Space Science and Exploratory Studies programme. He returned to Bell Labs in 1964. In 1969, he worked with George E. Smith to develop Charge-Coupled Devices (CCDs).

George Elwood Smith, born in 1930 in White Plains, New York, did his Ph.D from University of Chicago in 1959. He is retired Head of VLSI Device Department, Bell Laboratories, Murray Hill, USA. He was involved in a variety of investigations on junction lasers, semiconducting ferroelectrics, electroluminescence, transition-metal oxides, the silicon-diode-array camera tube, and Charge Coupled Devices (CCDs).

Boyle and Smith jointly invented the first successful imaging technology using a digital sensor, a Charge Coupled Device (CCD).



Charles K. Kao

Willard S. Boyle

George E. Smith

Fig. 3: Nobel Prize awardees in Physics

Fig. 4: Optical Fibres

(Source : ocw.mit.edu/.../detail/fibre_optics_hom.htm)

The CCD uses semiconductors, the same kind of materials as computer chips, to capture light and turn it into an electric signal. The CCD is the electronic eye of digital camera. The invention has revolutionised photography, as light could now be captured electronically instead of on films. The digital form facilitates the processing and distribution of these images. The CCD allowed whole two-dimensional fields of optical data to be read out more quickly and efficiently. The CCD has been the backbone of the commercial digital camera industry.

The CCD technology makes use of the photoelectric effect, as theorised by Albert Einstein and for which he was awarded the Nobel Prize in the year 1921. By this effect, light is transformed into electric signals. The challenge when designing an image sensor was to gather and read out the signals in a large number of image points, pixels, in a short time. Digital photography has become an irreplaceable tool in many fields of research. The CCD has provided new possibilities to visualise the previously unseen. It has given us crystal clear images of distant places in our universe as well as the depths of the oceans. The CCD contains a silicon chip that is divided into cells or "pixels". When light hits a pixel, it excites an electric charge in the silicon, which then induces a charge in a tiny electrode on the surface of the chip. The charge then quickly passes from electrode to electrode down a whole row of pixels known as "charge coupling" and is read out at the edge of the chip. The CCD technology is also used in many medical applications, e.g. for imaging the inside of the human body, both for diagnostics and for microsurgery.

Today optical fibres make up the circulatory system that nourishes our communication society. These low-loss glass fibres facilitate global broadband communication such as the Internet. Light flows in thin threads of glass, and it carries almost all of the telephony and data traffic in each and every direction. Music, video, Text and images can be transferred around the globe in a split second. Dr Kao carefully calculated how to transmit light over long distances via optical glass fibres. With a fibre of purest glass it would be possible to transmit light signals over 100 kilometres, compared to only 20 metres for the fibres available previously. His passion inspired other researchers to share his vision of the future potential of fibre optics. The first ultrapure fibre was successfully fabricated in 1970. This is one of the main technologies in modern photography. It makes the capture and reading of light fast and efficient and it essentially made photographic film obsolete, the cost of capturing an image went down to literally zero. It is also one of the standard technologies for investigation in astrophysics and most importantly, it is not restricted to the visible spectrum. This mode of communication is essential for high speed internet and forms the optical backbone of 21st century commerce.

Nobel Prize in Physiology and Medicine

This year's Nobel Prize for physiology and medicine is shared by three scientists: Elizabeth H. Blackburn, Carol W. Greider, and Jack W. Szostak for their discovery "how chromosomes are protected by telomeres and the telomerase enzyme".

Elizabeth H. Blackburn was born on 26 November 1948 in Hobart, Tasmania. She is an Australian born U.S. biologist and done her Ph.D. at University of California, San Francisco (UCSF), she studied telomere, a structure at the end of chromosomes which protects the chromosome.

Born in 1961 at San Diego, California, Carol W. Greider completed her Ph.D. in molecular biology in 1987 at the University of California, Berkeley, under Elizabeth Blackburn. Presently, she is a Professor and Director of Molecular Biology and Genetics at the John Hopkins Institute of Basic Biomedical Sciences. She discovered the enzyme telomerase in 1984 while working with Elizabeth Blackburn. She pioneered research on the structure of telomeres, the ends of chromosomes.

Jack W. Szostak was born on 9 November 1952 in London. He completed his Ph.D. from Cornell University (US). Presently, he is a biologist and Professor of Genetics at Harvard Medical School and Alexander Rich Distinguished Investigator at Massachusetts General Hospital, Boston. He is

Fig. 5: Nobel Prize awardees in Physiology and Medicine

Elizabeth H. Blackburn

Carol W. Greider

Jack W. Szostak

credited with the construction of the world's first yeast artificial chromosome. This construction helped him to map the location of gene in mammals which played a pivotal role in Human Genome Project. Dr Szostak's discoveries have paved the way to clarify the events that lead to chromosomal recombination, the reshuffling of genes that occurs during meiosis and also to unravel the function of telomere gene.

(1952-11-09) The DNA of all organisms (whether prokaryotic or eukaryotic) multiply (get divided) by a process called DNA Replication, such that the newly formed strand of DNA is the exact copy of its parent DNA. The replication process is different in prokaryotes and eukaryotes. In prokaryotes the circular DNA replication is terminated by Ter (terminus)-Tus (terminus utilisation sequences) complex sequences. But termination of linear eukaryotic chromosome involves the synthesis of special structure, called telomeres chromosome, present at the end of all eukaryotic chromosome. Telomeres consist of tandem repetitive arrays of the hexameric sequence TTAGGG and play an important protective role in the cells. Their presence on the tips of chromosomes prevents important genetic material from being lost during cell division. The overall size of telomere is ranging from ~15 Kilobase (kb) at birth sometimes 55 kb in chronic disease states. The telomeric repeats help maintain chromosomal integrity and provide a buffer of potentially expendable DNA. The ends of telomeres are protected and regulated by telomere-binding proteins and form a special lariat-like structure called the t-loop. This packaging or protective cap at the end of linear chromosomes is thought to mask telomeres from being recognised as broken or DNA damage, thus

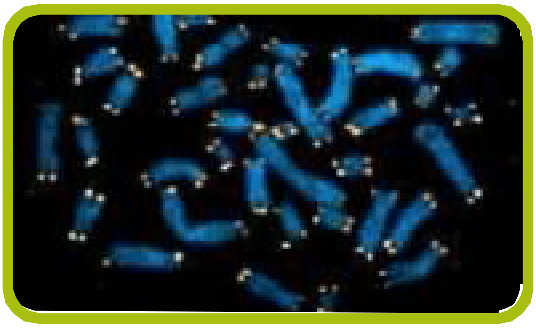


Fig. 6: Chromosome and Telomeric DNA

(Source : physics.berkeley.edu/.../yildiz/Research.html)

protecting chromosome termini from degradation, recombination and end-joining reactions.

Fig 6 depicts the chromosome in blue colour and the white point like structure present at the tip of chromosome is the telomeric DNA.

The inability of DNA polymerase to replicate the end of the chromosome during lagging strand synthesis ('end replication problem') coupled with possible processing events in both leading and lagging daughters, results in the loss of telomeric repeats each time a cell divides and ultimately leads to replicative senescence. This problem is solved by the 'Telomerase enzyme'. The telomerase is a ribonucleoprotein enzyme essential for the replication of chromosome termini in eukaryotes. It is an essential enzyme that maintains telomeres on eukaryotic chromosomes. The importance of telomeres was first elucidated in plants 60 years ago. Little is known about the role of telomeres and telomerase in plant growth and development. enzyme adding telomeric repeats onto the 32 This

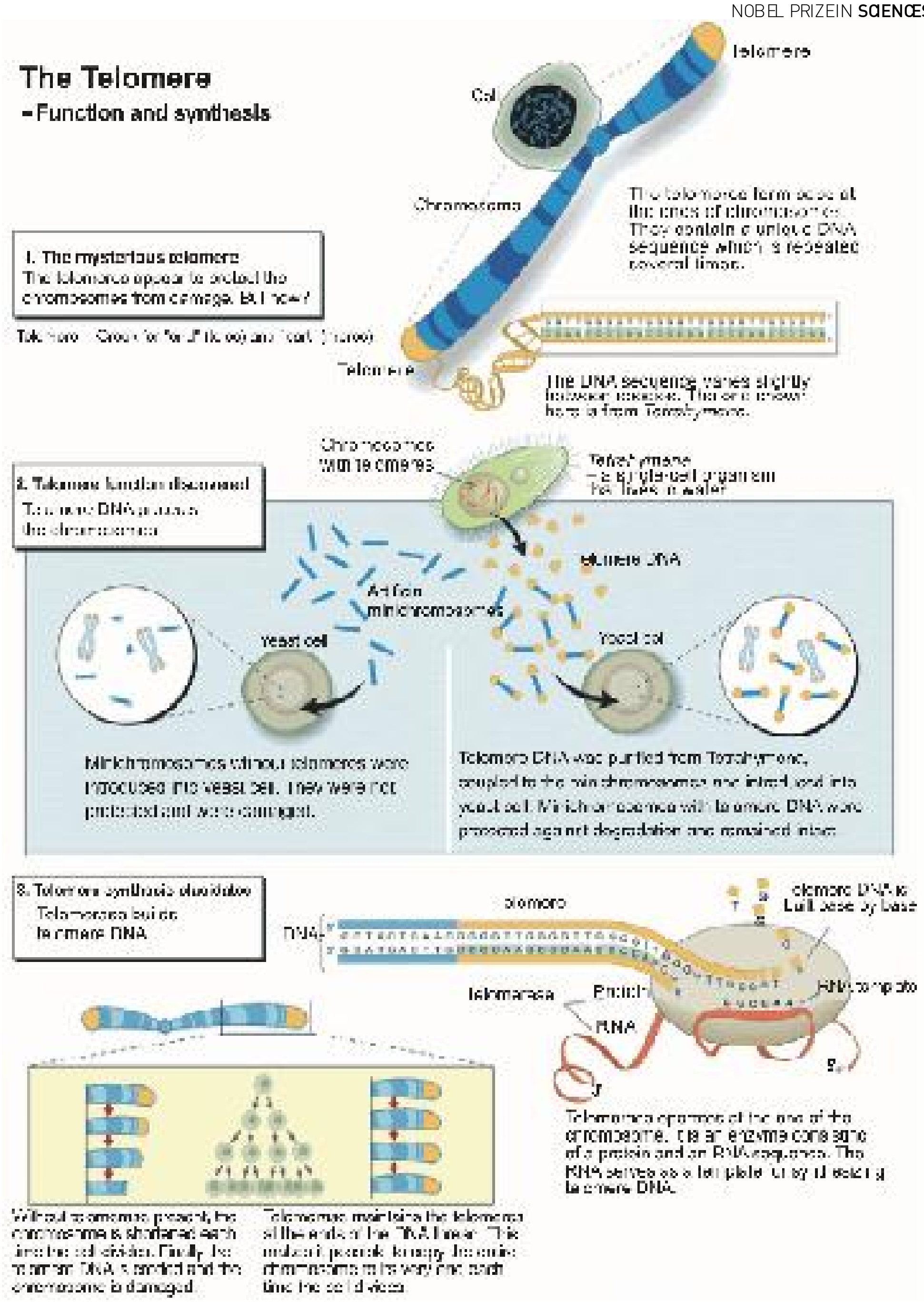


Fig. 7: Telemere Function and Synthesis

Source : www.highlighthealth.com/.../2009/10/telomere.gif ends (3 prime ends) of the DNA limits. Telomerase act like a cellular reverse transcriptase enzyme, which is RNA dependent DNA synthesis. The enzyme telomerase, which builds telomeres, enables the entire length of the chromosome to be copied without missing the end portion.

Telomerase uses its integral RNA component as a template in order to synthesise telomeric DNA (TTAGGG)n, directly onto the ends of chromosomes. After adding six bases, the enzyme pauses while it repositions (translocates) the template RNA for the synthesis of the next 6 bp repeat. This extension of the 32 DNA template eventually permits additional replication of the C-rich strand, thus compensating for the end-replication problem. Average telomere length, gives some indication of how many divisions the cell has already undergone and how many remain before it can no longer replicate.

All telomeres have the same short sequence of DNA bases repeated thousands of times. Rather than containing any genetic information, these repetitive snippets help keep chromosomes intact. Short telomeres are more common in older cells; telomere capping problems may be related to the development of age-related diseases. Telomerase expression is also detected in a majority of cancers, but is absent in most somatic tissues and correlates to clinical outcome in a number of cancer types. Cancer and aging research merge in the study of telomeres. The tails at the ends of chromosomes that become shorter as a cell divides, is defected in cancer cells. It divides continuously as cancer cell has uncontrolled growth regulatory system.

Role of Telomere and Telomerase in Cancer

In cancer cells, telomeres act abnormally; they no longer shorten with each cell division. Healthy human cells are mortal because they can divide only a finite number of times, growing older each time they divide. It has been proposed that telomere shortening may be a molecular clock mechanism that counts the number of times a cell has divided and when telomeres are short, cellular senescence (growth arrest) occurs.

The cancer cell has uncontrolled growth regulatory system as it divides beyond the normal limits. Telomerase is an enzyme that "rewinds" the mitotic or cellular clocks. Telomerase strengthens and lengthens the shortened telomeres in the cells, replacing the bits of DNA lost in normal cell division. If telomerase stops telomere shortening, those cells with telomerase can live forever. Since most cancer cells contain telomerase, researchers believe it is a critical factor in conferring immortality upon these cells.

Dr Blackburn and Dr Greider discovered the enzyme telomerase, which is not active in most adult cells but becomes active in advanced cancers, enabling cells to replace lost telomeric sequences and divide indefinitely. Their discovery therefore, might aid in cancer treatment. Lots of work is going on cancer which is related to telomerase enzyme. If the telomerase activity in the cancer cell stops or reduces then it is easy to cure to some extent the cancer in persons. Telomerase expression is associated with the stage of differentiation but not necessarily with the rate of cell proliferation. The inhibition or absence of telomerase may result in cell crisis in cancer cells and tumor regression in cancer patients. These results suggest that cancer therapy based on telomerase inhibition could be a more effective and safer treatment for cancer; it could as well provide a more accurate means for diagnosing and predicting clinical outcome in cancer. In addition, some inherited diseases are now known to be caused by telomerase defects, including certain forms of congenital aplastic anemia, and some inherited skin and lung diseases.

Role of Telomere and Telomerase in Aging

Natural aging involves the telomeres, which over time lose their ability to replicate as frequently as when they were younger. Aging is a progressive decline in vitality over time leading to death. It is a side product of metabolism. The process of cell division is called mitosis. Each time mitosis occurs, the telomeres of the dividing cells get just a bit shorter. Once a cell's telomeres have reached a critically short length, that cell can no longer divide. Its structure and function begins to fail, and some cells even die. The telomere hypothesis of aging postulates that as the telomeres naturally shorten during the lifetime of an individual, a signal or set of signals is given to the cells to cause the cells to cease growing (senesce). According to, Dr Langmore, at birth, human telomeres are about 10,000 base pairs long, but by 100 years of age this has been reduced to about 5,000 base pairs. Many scientists speculated that telomere shortening could be the reason for aging, not only in the individual cells but also in the organism as a whole. But the aging process has turned out to be complex and it is now thought to depend on several different factors, the telomere being one of them. In the absence of telomerase, the telomere will become shorter after each cell division. When it reaches a certain length, the cell may cease to divide and they die. Therefore, telomerase plays an essential role in the aging process. There is little evidence that commonly observed changes in older individuals, such as anemia and impaired wound healing, result from impaired cellular proliferation, which would be the anticipated consequence of shortened telomeres. Despite the lack of clear evidence for impaired proliferation in aging there is, in fact, good evidence for progressive telomere shortening in many human cell types, including peripheral white blood cells, smooth muscle cells, endothelial cells, lens epithelial cells, muscle satellite cells, and adrenocortical cells, etc. The proliferative capacity is closely related to telomere length in endothelial cells. Telomere lengths in endothelial cells decreases as a function of donor age, with a greater decline being observed in cells isolated from the iliac artery. The greater decline in telomere length was observed in the cells that have likely undergone more proliferation *in vivo*, because they resided in a part of the vascular system where blood flow might cause most chronic damage to the endothelium.

The discoveries of the Nobel laureates has added a new dimension to the scientific community's understanding of the cell, shed light on disease mechanisms, and introduced new directions for the development of potential new therapies.

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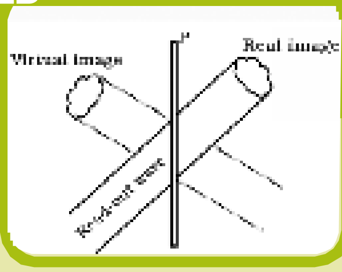
HOLOGRAPHY– THE FASCINATING WORLD OF 3-D VIEWING



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Memories of people, events etc. are better stored in the form of photographs. In fact, the technology of photography has been with us for a long time. Regular photograph "freezes" a two-dimensional image of the three-dimensional world, thereby enabling only a two-dimensional view of reality. Standard photographic film registers the total light intensity (which is square of amplitude of light wave) falling on each point of the film during exposure i.e. when the shutter is open. The resulting image is a two-dimensional mapping which contains only the intensity attributes of the wave. The phase attributes of the wave related to the depth of the field are therefore lost. An ordinary photography, therefore, loses the phase completely. It records only the intensities. However, if both the intensity and the phase attributes of the wave are recorded, one can get a three-dimensional image of the object. This is achieved by using the principles of what is known as holography.

History

The technique of holography was developed by the Hungarian physicist Dennis Gabor in 1948 when he was working in the Research laboratory of the British Thomson-Houstan Company in Rugby, England. This discovery won him the 1971 Nobel Prize in Physics.

In fact Gabor's interest was to improve the resolving power of the electron microscope. He used a two-step lensless imaging process that involved interference between an object wave (emanating from the object) and a coherent background wave (called reference wave). The resulting interference pattern was called a "hologram", after the Greek word *holos,* meaning whole as it contained the whole information. This is known as the recording process. Recorded in the interference pattern is not only the amplitude distribution but also the phase of the object wave.

The hologram has,however, little resemblance to the object. It has in it a coded form of the object wave. The second step in Gabor's process, called reconstruction process, involved reproduction of the image. The hologram was illuminated by an appropriate light beam which formed the reconstructed image of the object in its true three-dimensional form.

Although the principle of holography was laid down by Gabor in 1948, it attained practical importance in 1960 only after the advent of lasers. In 1962 Emmett N. Leith and Juris Upatnieks, working in the Radar Laboratory of the University of Michigan, succeeded in developing good quality holograms using laser light.

In 1962, Yuri Nikolayevitch Denisyuk of Russia introduced a scheme for generating holograms that was conceptually similar to the early colour photographic process of Gabriel Lippmann. He succeeded in producing a white light reflection hologram which, for the first time, could be viewed in light from an ordinary incandescent light bulb.

Another significant development in holography took place in 1969 when Stephen A.Benton of PolaroidResearch Laboratories, Cambridge,Massachusetts, U.S.A.succeeded in creating white light holograms. Depending on the viewing angle these holograms show all the seven colours constituting white light and are called "rainbow" or Benton holograms. In fact, such holograms are used on credit cards, magazines and other commercial products to prevent forgery. They find extensive use in the field of advertising, publishing and banking industries.

In 1972, Lloyd Cross developed a technique that combined white light transmission holography with the conventional cinematography. In this way he was able to develop integral holograms, called "integrams" Looking through a transparent cylindrical drum, the three-dimensional images can be seen in motion. Such holograms describing motion find applications in science fiction movies.

In 2008, optical scientists under leadership of Tay Peyghambariam working at the University of Arizona College of Optical Sciences in collaboration with Nitto Denko Technical Corporation, Oceanside, California, U.S.A. could make 3-D holographic displays that could be erased and re-written in a matter of minutes. Their device consisted of a special plastic film sandwiched between two pieces of glass each coated with a transparent electrode. In this device the images are "written" with the help of laser beams and an externally applied electric field into the light-sensitive plastic called 'photorefractive' polymer. The holographic displays in this new technique are capable of showing a new image every few minutes.

Principle of Holography

Holography is actually a two stage process which involves:

(i) Recording the hologram; and

(ii) Reconstruction of the image from the hologram.

For recording the hologram, a highly coherent laser beam is divided by a beam splitter into two beams, A and B. The beam A, known as the reference beam, hits the photographic plate

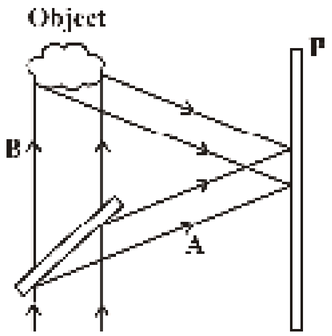

Fig. 1: Reading of a hologram

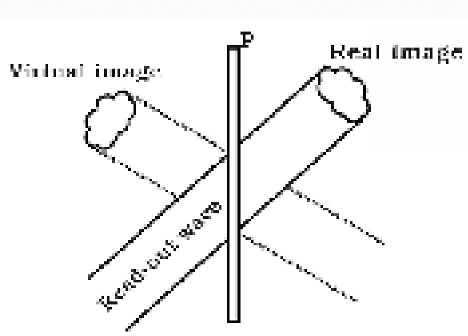

Fig. 2: Reconstruction of the image

directly. The beam B illuminates the object whose hologram is to be recorded .This gets scattered by the object.The scattered beam, called the object beam, impinges on the photographic plate. The superposition of the object beam and reference beam produces an interference pattern which is recorded on the photographic plate. The hologram thus recorded is quite unintelligible and gives no idea about the image embedded in it. However, it contains all the information about the object.

For viewing or reconstructing the image, the hologram is illuminated by the laser beam, which is called the read-out beam. This beam is identical with the reference beam used during the formation of hologram. The points on the hologram act as diffraction grating. The waves diffracted through the hologram carry the phases and amplitudes of the waves originally diffracted from the object during the formation of hologram. The diffracted beam in general, gives rise to two images–one virtual and the other real. The virtual image has all the characteristics of the object and can be seen on looking through the hologram. The real image, called pseudoscopic image, can be photographed directly without using a lens.

Instead of a conventional photographic film, holograms can also be recorded by using a digital device, e.g. a charged-coupled device (CCD) camera. Known as digital holography, the reconstruction process in this case can be carried out by digital processing of the recorded hologram using a standard computer. A three-dimensional image of the object can later be visualized on a computer screen or TV set.

Applications of Holography

Holography has wide range of applications in diverse fields. We shall mention here some of the important applications of holography in science and technology.

An important application of holography is in the field of information or data storage. The ability to store large amount of information is of great importance, as many electronic products incorporate storage devices. The advantage of holographic data storage is that the entire volume of the recording media is used instead of just the surface. Producing holographic CD storage is under intense research and it is estimated that lTB (terarbite) data can be stored on a holographic CD. Certainly, holographic data storage seems to have the potential of becoming the next generation of popular storage media.

Another major application of holography is in the coding of information for security purposes and in preventing forgery. Holograms having security features are often used in credit and bank cards, books, DVDs, branded products, etc. Some Indian and foreign currency notes too carry the security holograms.

Holographic microscopy is another potential application of holography. As is known, a conventional microscope has a small depth of field (the range of depth over which an object is in focus at any microscopic setting). Biological specimens, generally suspended in a fluid, move about making them sometimes in and sometimes out of focus of the microscope. However, this motion can be "freezed" in a hologram taken through the microscope. The reconstructed 3-D image can then be studied at leisure.

Holographic interferometry is yet another significant application of holography. It can be used for testing stresses, strains and surface deformations in objects. Holographic interferometry was actually a chance discovery made in 1965 by a number of groups working around the world. R. L. Powell and K. A. Stetson at the University of Michigan, Ann Arbor, made an interesting discovery in that year. They found that the holographic images of moving objects are washed out. However, if double exposure is used, first with the object at rest and then in vibration, fringes will appear indicating the lines where the displacement amounted to multiples of a half wavelength. In this way, Powell and Stetson could reconstruct vibrational modes of a loudspeaker membrane and a guitar. The principle of holographic interferometry by double exposure was discovered simultaneously and independently in 1965 by Haines and Hildebrand of the University of Michigan, Ann Arbor and also by J.M. Burch in England and by G.W. Stroke and A. Lebeyrie in Ann Arbor, Michigan.

Non-destructive testing by holographic interferometry is a very important industrial application of holography. The technique is able to detect even smallest defects. Applications of holographic interferometry have, therefore, resulted in the improvement and reliability of products.

Medical diagnostics is a new and emerging field of the applications of holography. Some of the prominent fields of medical sciences in which holographic technology is used are radiology, dentistry, urology, ophthalmology, orthopedics, pathology and so on. In the field of ophthalmology, for instance, any retinal detachment or foreign body can easily be detected.

Although holography has applications in diverse fields it still is a relatively expensive procedure. However it is expected that with time we would be able to get over the cost factor and holography will then have many more applications even in everyday life. There is no gainsaying the fact that potential for holographic technology is indeed limitless.

EPISODIC CONCEPTUALISATION–A POSSIBLE SOURCE OF ALTERNATIVE CONCEPTION ABOUT 'KINETIC ENERGY' AND 'WORK'

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In recent times, 'Episodic Conceptualisation' has been identified as one of the origins of pupils' alternative conceptions. It is hypothesized that the episodic format of the form, content, and mode of presentation of the concepts 'Kinetic Energy' and 'Work' in the textbook as well as in the classroom by the teacher is likely to generate in the minds of the pupils two isolated, mutually independent cognitive structures. It is conjectured that any task, which demands conceptual and/or mathematical correlation between these two concepts, is likely to bring to the fore pupils' alternative conceptions that are reflections of the above 'Episodic Conceptualisation'. The results of the present study do indicate that there are enough evidences to put faith on our hypothesis and conjecture in the framework of these two concept labels.

Introduction

The form, structure and focus of pupils' alternative conceptions (hereafter referred as ALCONs) in the recognizable cognitive structures of pupils and their importance for the teaching-learning process have been well documented in the last two decades through intensive and extensive researches on itemised concepts. Informative reference details in a discipline-wise classification format can be obtained from the monograph by Pfundt and Duit (1994). These studies are interesting to researchers, informative for curriculum framers, and educative for students of science education. But, in a framework of 'research for teaching' and 'teaching for research', the full potential of these findings in helping the classroom practitioner to improve /modify his/her teaching strategies so that pupils can be helped to construct their concepts in a way the teacher expects them to construct, is yet to be realised. In fact, in an earlier paper, Driver (1989) had commented that the efforts to optimise meaningful learning by using these findings in classroom situations have resulted in partial to apparent success.

We suggest that the functional limitation of the efforts could be due to the following reasons.

(1) The individualistic character of ALCONs has remained the main hurdle that has appreciably reduced the applicability of our wealth of knowledge in this area. If, in a class, there are 30 pupils, then theoretically there will be 30 independent ALCONs for each new concept that is going to be taught. Thus, to diagnose these 30 ALCONs and then use them meaningfully through cognitive negotiation so as to help the pupils construct the new concept becomes a Herculean task for the teacher. In some school systems, the number of pupils in a class is actually more than 30 thereby compounding the problem further.

(2) All the techniques available in the literature have been used only to identify the ALCONs and not to diagnose their genesis. This is like identifying a disease without diagnosing its cause. Since it is acceptably true that any prescription is as good as the quality of diagnosis about the cause, it is obvious that suggestions as well as efforts for the use of the research findings (about ALCONs) in a classroom situation will have limited utility in the absence of confirmed evidences regarding the genesis of the ALCONs.

One possible way to remove the two limitations at a single stroke is to attempt to locate the genesis (thereby improving the functionality of a prescription) that is likely to produce a common ALCON in a group of pupils (thereby eliminating the problems created by the individualistic character of the ALCONs).

Hence this study, which makes an effort to reconfirm Episodic Conceptualisation as a possible cause of group ALCONs as identified earlier by Mohapatra (1990), at least in Indian conditions.

Episodic Conceptualisation

Classroom teachers are often heard to say, "We have now finished 'Mechanics'; in the next class we move on to 'Gravitation'", or, similar statements in other discipline areas. This 'atomized' view is seen in the school curriculum, in teaching methods, and even in most of the textbooks, at least in the Indian context. A comprehensive example could be – in textbooks, 'Simple Harmonic Motion' or 'SHM' is included in the 'Mechanics' chapter. 'SHM' is again discussed with a different emphasis in the chapter on 'Waves'. 'SHM' reappears with different variables and thrusts in 'A.C. Circuits'. And, finally, the principles of 'SHM' are again used and discussed under wave theory of 'Optics'. Each unit is treated as an isolated episode and sometimes even as a consumption of identifiably different sub-episodes. For example, in physics textbooks, the unit on 'Mechanics' usually contains kinetics of linear motion, uniform circular motion, and rotation of rigid bodies as different sub-episodes.

How is this episodic format likely to affect conceptualisation by pupils? In a Piagetian sense, each pupil internalises a concept by going through the processes of assimilation, accommodation, and arriving at a state of equilibration. In a Constructivist Framework (Glasersfeld, 1992(a); 1992(b); 1993) these three processes are controlled and effected by the pupil's ALCONs, his/her 'Cognitive Preference' (Tamir, 1985), his/her 'Conceptual Categorisation' (Hewson and Thornley, 1989; Mohapatra, 1999), and finally result in a 'Conceptual Change' (Posner *et al*, 1982; Hewson and Thornley, 1989; Scott, Asoko and Driver, 1991; Mohapatra, 1997). With the acquisition of a new concept through conceptual change leading to equilibration, one of four possibilities may occur:

(a) The boundary of the earlier equilibration may change to engulf the new concept. This is likely to happen when the pupil discovers a cognitive link between the new concept and an extension of the already internalised old concept (Conceptual integration: Hewson, 1981; Posner *et al*, 1982; Villani, 1992; Mohapatra, 1997).

(b) The new concept may be accommodated in the domain of the existing equilibration by developing new substrates (Conceptual extension: Mohapatra, 1997).

(c) The new concept may be incorporated straight away in the existing structures (Conceptual capture: Hewson, 1981; Posner *et al*, 1982; Mohapatra, 1997).

(d) A new and different state of equilibration may start to be formed, if the new concept presented is intelligible, plausible and fruitful, but is in dissonance with the existing structures (Villani, 1992; Mohapatra, 1997).

The episodic format of the presentation of different units and sub-units in the textbooks and the classroom is likely to induce the pupil to develop pockets of isolated, unconnected states of equilibration. This form of internalisation and information processing of concepts may be called 'Episodic Conceptualisation' (EpiCon). Claxton (1984) calls concepts internalised by the pupils in this process of conceptualisation as 'mini-theories' as it highlights the fact that the pupil does not have a complete, comprehensive and coherent theory, but has many little islands of knowledge.

It is hypothesized (Mohapatra, 1990) that

(a) In the framework of such episodic cognitive structures, if a pupil is asked a question that needs the simultaneous utilisation of different states of equilibration, then he/she is likely to give responses which will be categorised as manifest ALCONs.

(b) Since such an EpiCon is likely to take place inside a classroom, it will probably affect a group of pupils simultaneously and in a similar way. Hence an effective classroom strategy can perhaps be designed to erase/modify the consequent ALCONs.

(c) Assuming the existence of the phenomenon of EpiCon it is proposed that, whenever a simultaneous application of more than one episode is demanded from the pupil, there will be two processes through which the ALCONs may manifest because of the EpiCon. First, the 'process of misuse'- the pupil may misuse one or more of the concepts. The misuse could be in the form, structure, and/or domain of validity of the concepts. Second, the 'process of nonuse'- the pupil may not use one or more of the relevant concepts and thus may arrive at a conclusion, which will be regarded as an ALCON.

'Kinetic energy' and 'Work': the Background

Children are exposed at a very early age to the term 'energy', if not through textbooks, at least through multimedia advertisements (Indian context), as "Beverage X is the source of my energy." Children see on the TV screen that the person (model) drinks a cup of the beverage X and starts running vigorously, ultimately securing first position in a race. Regular viewing of such advertisements obviously creates in the mind of the child an 'anthropocentric' framework (Watts, 1983; Finegold and Trumper, 1989; Trumper, 1990), i.e. 'energy' is associated with human beings. With this framework a cognitive image where the term 'energy' seems to have close association with a picture of vigorous expression/activity (a la kinetic energy) also gets embedded. Further, the child may also get reinforcement of such an ideational structure from (Elkana, 1967) the Oxford English Dictionary, which defines 'energy' as 'force of vigour or expression' and traces it back to 1599.

In Indian schools, the concepts of 'work' and 'energy' are included in *Environmental Studies* up to Class V in an informal way highlighting the everyday meaning of these concepts rather than their formal scientific meaning. Again in Class VI these concepts are presented in a mixed manner along with 'food' in the chapter on *Components of Food.* In Classes VII and VIII, the concepts are almost absent from the texts. The concepts of 'work' and 'energy' are formally introduced in the science textbook at Class IX in the chapter titled, *Work and Energy.* Starting with the everyday meaning and scientific meaning of the term 'work', work done by a constant force is defined as the product of the force and displacement occurring in the direction of the force. 'Energy' is then expressed in terms of 'work'- "An object having a capability to do work is said to possess energy". 'Kinetic' and 'potential' forms of energy are introduced next. Mathematical expression for kinetic energy possessed by a moving body is derived. Mathematical relation for computing potential energy is also worked out for the case of a body raised against gravity. Also discussed are the transformation of energy from one form to another and the law of conservation of energy (not the law of conservation of energy and work).

Thus, by the end of Class IX, the pupils are expected to have definite ALCONs about energy in general and kinetic energy in particular as well as about work. These ALCONs will ultimately control (Ausubel, 1968) their degree of meaningful learning about 'energy' and 'work', taken in conjunction.

There have been a number of studies (Watts, 1983; Duit, 1984; Bliss & Ogborn, 1985; Gilbert & Pope, 1982, 1986; Trumper, 1990, 1993, 1996, 1997; Finegold & Trumper, 1989) on pupils' ALCONs about energy. Attempts (Watts, 1983; Trumper, 1997) have also been made to categorise the ALCONs into classes. However, to the best of our knowledge, no work is reported in the literature which makes efforts to locate pupils' ALCONs as well as their genesis in the conceptual interface between 'kinetic energy' and 'work', although this is an important area since energy is defined as the ability to do work.

Episodes involving 'Kinetic Energy' and 'Work'

The following sub-episodes, involving kinetic energy and work, were identified by

- analysing the science textbooks (NCERT) of classes VI to X,
- observing actual classroom teaching,
- discussing with practicing teachers, and
- interviewing pupils of the above classes.

Each sub-episode is followed by a heading 'Result', which indicates the thought process (as revealed through interview) of the pupils because of the internalised sub-episode and also highlights the details of misuse and/or nonuse of an episode by the pupils.

E1: Kinetic energy of a body depends on its velocity.

Result

(a) Velocity is the only key factor of kinetic energy of a body (This indicates misuse of E1).

(b) Some pupils are of the opinion that same kinetic energy means the same velocity (This indicates misuse of E1).

(c) Contribution of mass of a body to its kinetic energy is rarely taken note of (This indicates nonuse of the fact that kinetic energy of a body depends also on its mass).

E2: Work is defined as the product of the applied force and the displacement of the body in the direction of the force.

Result

(a) Work – Force ´ Distance traveled [This indicates (i) misuse of E2, (ii) nonuse of the vector property of force and displacement, and (iii) misusing 'distance' as synonymous with 'displacement'].

(b) As a corollary of (a) above – If a body travels through a distance due to the application of a force, then work is done even if the displacement is zero or the angle between the applied force and displacement is 90°.

(c) For work to be done there must be application of a visible force like a push or a pull (This indicates nonuse of the statement that 'Energy is the ability to do work' and consequently, a body having energy can do work).

E3: Conversion of potential energy to kinetic energy in the case of vertical free fall of a body.

Result

(a) Bodies released from the same height will attain the same velocity on reaching the ground. So, they will have the same kinetic energy [This indicates misuse of E1 and effects of 'Result' (b) and (c) of E1].

(b) If two different bodies are thrown vertically up and have the same kinetic energy at the moment of throw, they will rise to the same height (This indicates misuse of E1 and E3).

E4: Because of E3 the concept of gravity and gravitational force becomes a sub-episode in the cognitive domain of work and kinetic energy.

Result

(a) Larger body means larger gravitational force and hence larger velocity resulting in higher kinetic energy (This indicates misuse of E4).

E5: Because of E2, the concept of force becomes a sub-episode in the cognitive domain of wok and kinetic energy.

Result

(a) Same force acting for the same time leads to same amount of work and same kinetic energy (This indicates misuse of E1 and E2).

(b) It is difficult to stop heavier bodies in motion (This indicates misuse of E2 and the concept of force).

(c) As a subset of (b), above conclusions about the effect of force of friction (introduced in Class VIII) are similar to (b) above.

E6: 'Energy', in general, and 'kinetic energy', in particular, and 'work' are different episodes.

Result

(a) Difficult to conceive about the inter-conversion of kinetic energy and work (This indicates nonuse of E1, E2 and the concept that 'Energy is the ability to do work').

Method

Tool

The tool consists of six problems (Annexure – I). All of them are conceptual ones although some of them carry numerical data about masses of objects involved in motion. Each question has three choices as responses and the subjects were asked to tick the one that in their opinion was the correct response. Care was taken to provide some space after every question, requesting the subjects to write down the reasons for ticking any particular response. This provision was made to probe their thought process. One (Q.4) out of the set of six questions was intentionally framed in a form similar to that in the prescribed textbook with the intention of peeping into the stabilised imprint in the minds of the pupils as produced by the textbook. The tool was finalised after initial try out on a sample of 50 pupils of Class X.

Sample

The sample consists of 334 pupils of Class X drawn from 5 schools, in and around the city of Bhopal. Care was taken to include government schools and schools run by private trusts. All the schools chosen were affiliated to the Central Board of Secondary Education (CBSE), New Delhi, India. This choice was prompted by the following considerations.

- The medium of instruction in all these schools is English. This uniformity is likely to minimise differentiated ALCONs arising out of linguistic differences.
- All the schools follow the same textbooks and hence the effects that are likely to manifest due to different textbooks are almost eliminated.
- As part of the conditions of affiliation, the science teachers of all these schools are graduates who have gone though at least one year of professional teacher training programme. This is likely to bring some normative effect on the teaching inputs and styles of teaching science in these schools.

- Even the physical facilities in these schools are above an optimal minimum, again because of the same affiliation conditions.
- Last, but not the least, the discipline in all these schools is above satisfactory level and, as a result, rarely classes are dropped because of uncalled for reasons.

In Table 1, NCERT stands for National Council for Educational Research and Training, the apex body of the Government of India looking after the quality of school education, KVS acronym for Kendriya Vidyalaya Sangathan, and JNVS is that for Jawaharlal Navodaya Vidyalaya Sangathan, later two being the school systems also under the Government of India.

Table 1: School-wise number of students of Class X constituting the sample

Name of the school	No. of pupils	Remark
Demonstration Multi-purpose School (DMS)	57	Run by NCERT
Kendriya Vidyalaya No. 1 (KV 1)	74	Run by KVS
Kendriya Vidyalaya No. 2 (KV 2)	58	Run by KVS
Carmel Convent (C C)	101	Run by private trust
Jawaharlal Navodaya Vidyalaya (JNV)	44	Run by JNVS

Administration

In the trial administration, it was observed that pupils took about 30 minutes to complete the test. Thus, the test was administered in a regular class in presence of the class-teacher and in a pupil friendly atmosphere.

Results and Discussions

The following can be easily discerned from the tool.

(a) The first question calls for the understanding of conversion of kinetic energy to work against the frictional forces of the brakes. But, from the pupils' point of view, several sub-episodes, like kinetic energy, work, frictional forces, their effects keeping in view the different masses of the two vehicles etc. come into play.

(b) The second question, though seems to be familiar from the point of view of the pupils, is actually different in the sense that pupils study the conversion of kinetic energy to potential energy only in the case of a body falling freely under gravity. Thinking this to be a similar phenomenon they may even tick the third option, thereby forgetting that potential energy of a body raised to a height 'h' is mass dependent because this potential energy is the work done against the gravitational force.

(c) In the third question they are again confronted with the situation of work being converted to kinetic energy. However, in the context of work, the concepts 'force' and 'distance' are so deeply embedded in their minds that they are likely to forget the role of time interval here and be guided by their episodic conceptualisation [Refer 'Result' (a) of E5].

(d) Question 4 should be most familiar to them as it has a direct correspondence with what is taught in the class, but data regarding masses will perhaps excite their minds another episode involving force and mass apart from the episode of conversion of work to kinetic energy.

(e) Question 5 is again a variation of what they have studied and it brings into play the episode of initial kinetic energy along with the episode of free fall.

(f) Questions 1 and 6 have the same conceptual structure but the situation in Q.1 is familiar to the pupils and that in Q. 6, is unfamiliar. This unfamiliarity may activate different episodes in different pupils. Hence the pattern of responses of Q. 1 and Q. 6, though expected to be similar, is likely to be different.

Percentage of pupils preferring particular responses are presented in Table 2. In Table 2 asteriked responses are the correct ones.

After the test was administered, the pupils preferring incorrect responses were engaged in group discussions. The indications received from written explanations by the pupils and the group discussions about the interplay of episodes are shown in the last column in Table 2. In some cases it was discovered that pupils arrived at even the correct responses by employing wrong reasons, an example of which is given below.

Researcher : Against Q. 2 you have ticked the response (a) as correct.

Pupil : Yes, Sir.

Researcher : Congratulations, that is the correct answer.

Pupil : Thank you, Sir.

Researcher : But let us discuss this a little more. How did you arrive at this answer?

Pupil : Sir, it is very simple.

Researcher : What is so simple about it?

Pupil : Sir, if the body is light, a force will produce a greater velocity in it. (*)

Researcher : Greater velocity or greater acceleration?

Pupil : Sir, ultimately it amounts to the same thing. (**)

Researcher : Then...........

Pupil : Sir, if the velocity is greater, then the body will rise to a greater height.

Researcher : But in this case, the force which is acting due to gravity is downwards and the body is moving upwards.

Pupil : (Thinks) ... Sir ... Yes ... Sir ... But ...

Researcher : So, what is 'But'?

Pupil : Sir, I do not know. But I know A's velocity will be more and it will rise to a greater height. (***)

The response, (*), clearly shows the activation of E2 and manifestation of an ALCON. Response, (**), is also an ALCON arising out of conceptual

Table 2 : Percentage of pupils preferring each response, question-wise
(The asteriked responses are the correct ones)

Q. No.	Suggested response symbol	Percentage of pupils preferring each response						Episodes involved
		Various schools						
		DMS	KV1	KV2	CC	JNV	All Schools	
1.	a	21.0	40.5	39.6	51.5	45.4	41.0	E5, E6
	b	50.8	43.2	37.9	27.7	27.3	36.8	E2, E6
	c*	28.0	16.2	20.7	16.8	27.3	20.6	
2.	a*	73.7	71.6	56.9	80.0	61.4	70.6	
	b	26.3	17.6	25.8	14.8	31.8	21.5	E4, E5
	c	1.8	13.5	17.2	3.0	6.8	8.1	E3
3.	a	64.9	48.6	53.4	42.6	47.7	50.3	E1, E2
	b*	26.3	28.4	22.4	28.7	29.5	27.2	
	c	12.3	20.3	29.3	13.8	18.2	18.3	E2
4.	a	15.8	44.6	13.8	34.6	34.1	29.9	E1, E2, E6
	b	68.4	40.5	55.1	34.6	45.4	46.7	E1, E2, E6
	c*	15.8	13.5	31.0	31.7	13.6	22.4	
5.	a	70.0	40.5	48.3	60.4	43.2	53.3	E4, E5
	b*	10.5	4.0	6.4	10.9	9.1	8.2	
	c	17.5	52.7	43.1	24.7	47.7	32.7	E4, E5
6.	a	42.0	54.0	55.2	49.5	54.5	50.9	E2, E5, E6
	b	52.6	23.0	24.1	31.7	25.0	31.1	E5, E6
	c*	3.5	14.9	18.9	16.8	20.4	14.9	

continuity (Mohapatra and Bhattacharya, 1989). The response, (***), shows an ad hoc element in the conceptualisation scheme of the pupil.

Some of the identified key ALCONs arising out of the episodic nature of internalisation of the concepts 'kinetic energy' and 'work' in this study are the following.

- The loaded truck will travel a longer distance because its mass is more and it will be difficult to stop it.
- Two bodies of different masses thrown vertically upwards with the same kinetic energy will rise to the same height because their kinetic energy is the same.
- If two bodies are acted upon by the same force for the same time they will have the

same kinetic energy as the time for which the force acts is the same.

- If two bodies are acted upon by the same force until they travel the same distance, then the lighter body of the two will have greater kinetic energy as its velocity will be larger.

- If two bodies are released from the same height with the same kinetic energy, then both will reach the earth's surface simultaneously since the height of release is the same.

At this time, it is worthwhile to look at the responses to Q.4, which we thought was most familiar to the pupils. Even in this case, about 15 per cent to 30 per cent pupils of various schools and 22 per cent when all schools are taken together, have ticked the correct response. For the rest 78 per cent their episodic conceptualisation has controlled their responses. This again indicates the strong effects of episodic conceptualisation. We also note in passing that in some cases the percentages do not add up to 100. This is so because in those cases some pupils did not tick any of the responses.

Conclusion

By a fairly broad-based strategy we have identified in this study the structures of the episodes/sub-episodes in the minds of pupils in the domain of interaction of the concepts 'kinetic energy' and 'work'. Through discussions with the pupils and their written explanations, the possible ALCONs generated by these episodes/sub-episodes have been located. The interplay of the episodes/sub-episodes (which are perhaps unconnected structures in the pupils' comprehension domain) when more than one of them is simultaneously activated, is then investigated to diagnose manifest ALCONs. The tool used for this comprises six conceptual problems. Consequently, it did not put any demand on the skills of the pupils such as

- numerical computation,
- transforming symbols in formulae to numbers by substituting the given data, and
- interpretation of the results, obtained through numerical calculations.

Thus, any ALCONs, which are likely to arise out of the pupils' deficiencies in these skills, have been minimised.

To eliminate the ALCONs, the following strategies are suggested, which can be used to promote meaningful learning and reduce episodic conceptualisation, in this context, to the minimum.

- Enough emphasis be given on the interchangeability of 'energy' and 'work', in general and 'kinetic energy' and 'work', in particular, keeping in view the accepted definition that energy is the ability to do work.

- Activities be developed to demonstrate the above interchangeability. As for example, pupils may be asked the following:

  — We know that a duster on the table has potential energy equal to mgh, where m is the mass of the duster and h is the height of the table. Since 'energy is the ability to do work', design an experiment to show that the duster can do work.

— Thought provoking, interesting and challenging conceptual problems may be given. As for example,

— When a bow is taut, it is said that the bow has potential energy. Describe how this energy is transformed to work.

— A steel ball is rolling on a table having friction. After travelling some distance it comes to rest. In the above process describe who is doing work.

Of course, each of the problems used here as test items of the tool may also be used as problems in a classroom situation.

One of the authors is thankful to R. Trumper for providing a few supportive literatures involving the concept of energy.

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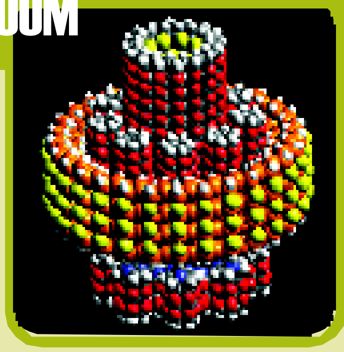
NANOSCIENCE CURRICULUM IN SCHOOL EDUCATION
INTEGRATING NANOSCIENCE INTO THE CLASSROOM



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Learning does not just mean studying for addition to qualifications or to improve job opportunities. It should be geared up to open up one's mental abilities to explore a wide range of activities that facilitate widening the horizon of understanding nature and natural phenomena besides expanding scope for and physical opportunities. NCERT is committed to building a world-class education and training framework. In order to accomplish its mandate for improving the quality of school education it strives continuously to develop, upgrade and modernise school curriculum, assessments and examinations. Main objective of these interventions is to provide a coherent and integrated curriculum and assessment framework for schools, which, in turn, may raise standard of achievement and widen educational opportunity.

Nanoscience and nanotechnology has led to an unprecedented excitement in the scientific and engineering communities, especially during the last decade. The recent revolutionary advances in nanoscale phenomena open exciting, new avenues for research and discovery. The potential contributions of advances in nanoscale phenomena to improve human health created even more excitement by envisioning new biomaterials, devices and techniques for biological detection and remediation. Thus, issues such as synthesis, fabrication and characterisation of functional nanomaterials and nanostructures for biomedical applications (molecular recognition, nanotubes, nanowires, nanoparticles, self-assembly, polymer-based nanomaterials, thin films, medical imaging, diagnosis and therapy, etc.) become very important. In recognition of this potential, we are proposing a new curriculum at senior secondary level school education. We also provide a lesson plan that would help teachers in dealing with this topic of interest.

Nanotechnology deals in the realm of the nearly invisible. The word comes from the Greek nanos, meaning "dwarf". But by most accounts, the technology's potential is anything but small. Scientists and engineers can now physically work with materials at the atomic level to create stain-proof fabrics, scratch-resistant paints and longer-lasting tennis balls. And researchers say new medical diagnostic tools and smaller, more efficient fuel cells and batteries based on nanoscience are on the way.

According to Chad Mirkin, Director of the Institute for Nanotechnology at Northwestern University, "It has only been in recent times that we've had the tools that allow us to manipulate atoms and molecules. There is a big shift here in the way we approach science and the way we approach engineering and ultimately the way we approach medicine. And I think in many respects it is revolutionary."

From computer chips invisible to the naked eye to microscopic machines that seek out and destroy cancers inside the human body, many scientists contend that the potential of nanotechnology could be endless, but not without controversy. There are hundreds of nano-enhanced products already in the marketplace. But there are virtually no regulatory guidelines for their manufacture and distribution.

Nanotechnology Lesson Plan

This lesson plan has been prepared to serve as a model to help senior secondary school science teachers to develop their own plan for an introduction to nanotechnology in a classroom setting.

Introduction to the Concepts of Nanotechnology is the study and use of structures between 1 nanometre and 100 nanometres in size.

Ask the students : What is the smallest thing you can imagine? Answers might include a human hair, the head of a pin, or an atom.

Reading : Now have students read the following :

Introduction to Nanotechnology

Nanotechnology is defined as the study and use of structures between 1 nanometre and 100 nanometres in size. To give you an idea of how small that is, it would take eight hundred 100 nanometre particles side by side to match the width of a human hair.

Looking at Nanoparticle

Scientists have been studying and working with nanoparticles for centuries, but the effectiveness of their work has been hampered by their inability to see the structure of nanoparticles. In recent decades the development of microscopes capable of displaying particles as small as atoms has allowed scientists to see what they are working with.

Figure 1 provides a comparison of various objects to help you begin to envision exactly how small a nanometre is. The chart starts with objects that can be seen by the unaided eye, such as an ant, at the top of the chart, and progresses to objects about a nanometre or less in size, such as the ATP molecule that store energy from food in humans.

Now that you have an idea of how small a scale nanotechnologists work with, consider the challenge they face. Think about how difficult it is for many of us to insert thread through the eye of a needle. Such an image helps you imagine the problem scientists have while working with the nanoparticles that can be as much as one millionth the size of the thread. Only through the use of powerful microscopes can they hope to 'see' and manipulate these nano-sized particles.

The Nanotechnology Debate

There are many different points of view about the nanotechnology. These differences starts with the definition of nanotechnology. Some define it as any activity that involves manipulating materials between one nanometre and 100 nanometres. However, the original definition of nanotechnology involved building machines at the molecular scale and involves the manipulation of materials on an atomic (about two-tenths of a nanometre) scale.

The debate continues with varying opinions about exactly what nanotechnology can achieve. Some researchers believe nanotechnology can be used to significantly extend the human lifespan or produce replicator-like devices that can create almost anything from simple raw materials. Others see nanotechnology only as a tool to help us do what we do now, but faster or better.

The third major area of debate concerns the timeframe of nanotechnology-related advances. Will nanotechnology have a significant impact on our day-to-day lives in a decade or two, or will many of these promised advances take considerably longer to become realities?

Finally, all the opinions about what nanotechnology can help us achieve echo with ethical challenges. If nanotechnology helps us to increase our lifespans or produce manufactured goods from inexpensive raw materials, what is the moral imperative about making such technology available to all? Is there sufficient understanding or regulation of nanotech based materials to minimise possible harm to us or our environment?

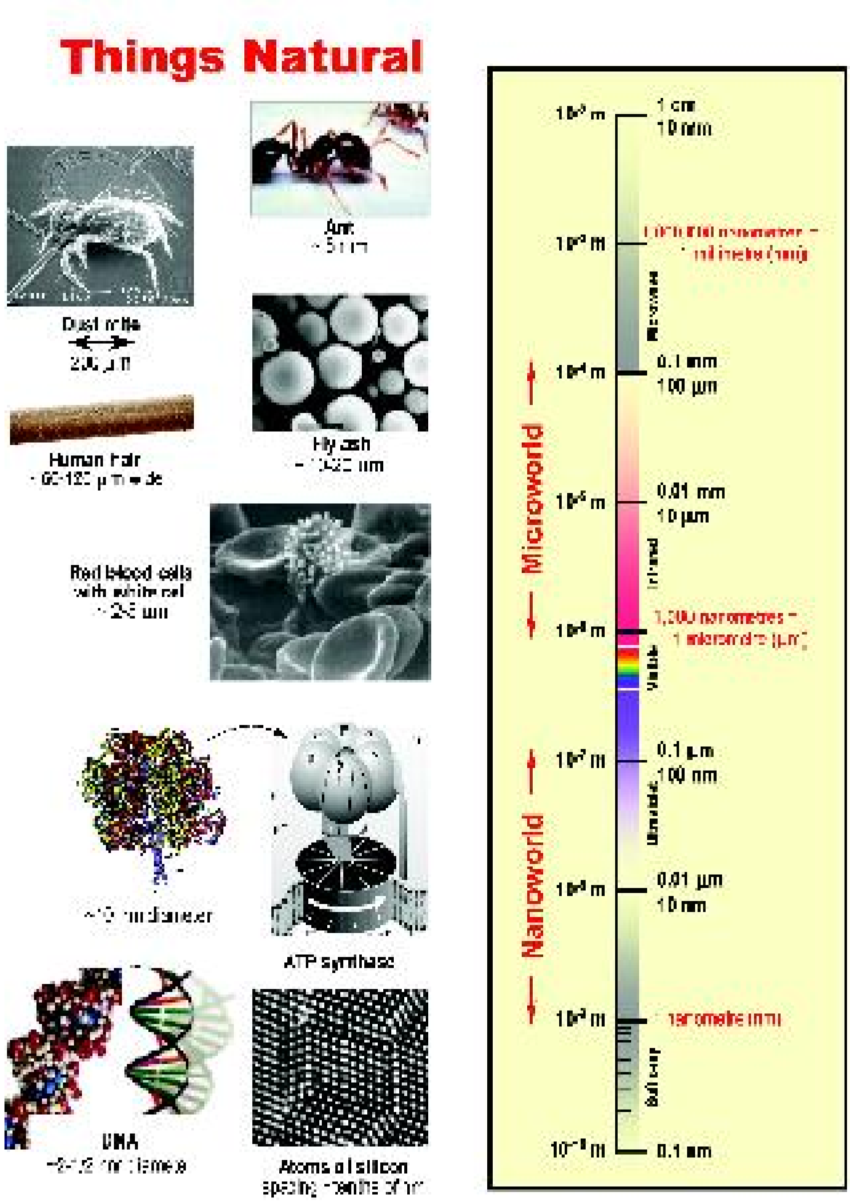
Only time will tell how nanotechnology will affect our lives, the following topics will help you understand the possibilities and anticipate the future. The following section is dedicated to provide clear and concise explanations of nanotechnology applications.

Nanotechnology Applications

The ability to manipulate nano-sized materials has opened up a world of possibilities in a variety of industries and scientific endeavors. Because nanotechnology is essentially a set of techniques that allow manipulation of properties at a very small scale, it can have many applications, such as:

Drug delivery: Today, most harmful side effects of treatments such as chemotherapy are a result of drug delivery methods that don't pinpoint their intended target cells accurately. Researchers at Harvard and MIT have been able to attach special RNA strands, measuring about 10 nanometres in diametre, to nanoparticles and fill the nanoparticles with a chemotherapy drug. These RNA strands are attracted to cancer cells. When the nanoparticle encounters a cancer cell it adheres to it and releases the drug into the cancer cell. This directed method of drug delivery has great potential for treating cancer patients while producing less side effects than those produced by conventional chemotherapy.

Fabrics : The properties of familiar materials are being changed by manufacturers who are adding nano-sized components to conventional materials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Ant
Dust mite
Human hair
Fly ash
Red blood cells
ATP synthase
DNA
Atoms of silicon
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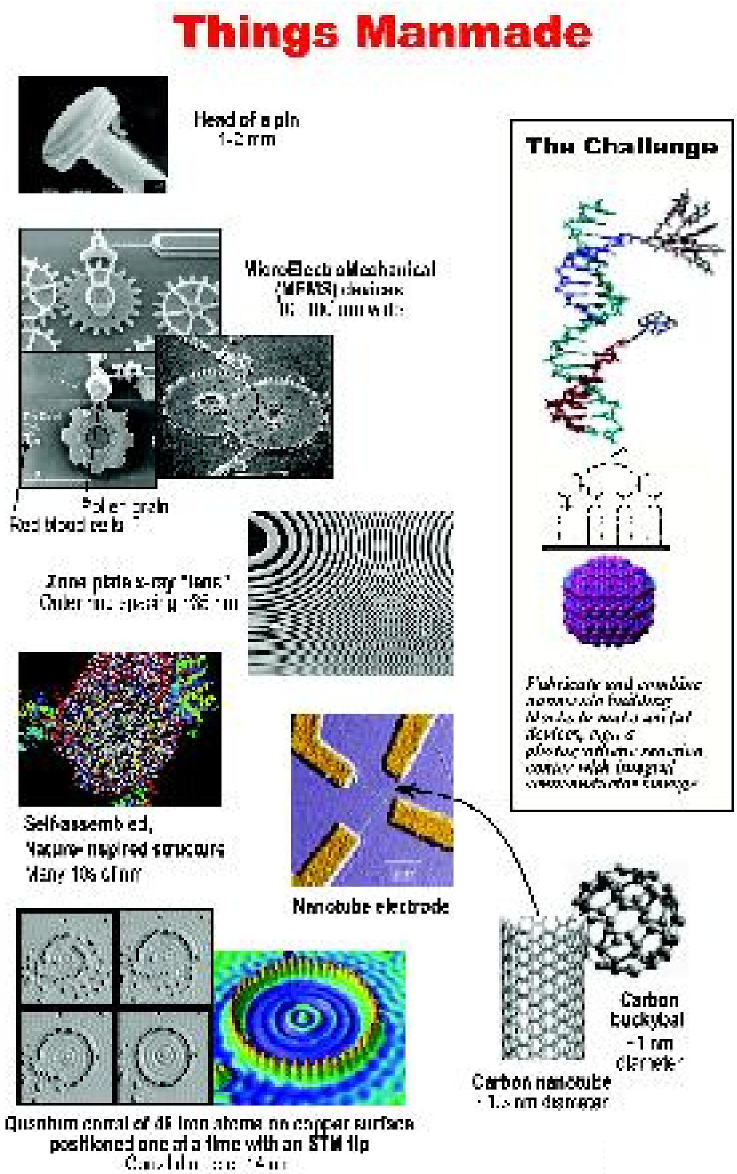

Fig. 1 The Scale of Things: Nanometres and more
(Source: www. highlight healt h. com/.../2009/10/telom ere.gif)

to improve performance. For example, some clothing manufacturers are making water and stain repellent clothing using nano-sized whiskers in the fabric that cause water to bead up on the surface.

Making composite fabric with nano-sized particles or fibres allows improvement of fabric properties without a significant increase in weight, thickness, or stiffness as might have been the case with previously used techniques.

Reactivity of materials : The properties of many conventional materials change when formed as nano-sized particles (nanoparticles). This is generally because nanoparticles have a greater surface area per weight than larger particles; they are therefore more reactive to some other molecules. For example, studies have shown that nanoparticles of iron can be effective in the cleanup of chemical in groundwater because they react more efficiently to those chemicals than larger iron particles.

Strength of Materials : Nano-sized particles of carbon, (for example nanotubes and bucky balls) are extremely strong. Nanotubes and bucky balls are composed of only carbon and their strength comes from special characteristics of the bonds between carbon atoms. One proposed application that illustrates the strength of nanosized particles of carbon, is the manufacture of bullet proof vests made out of carbon nanotubes which weigh as less as a T-shirt.

Micro/Nano Electro Mechanical Systems : The ability to create gears, mirrors, sensor elements, as well as electronic circuitry in silicon surfaces allows the manufacture of miniature sensors such as those used to activate the airbags in your car. This technique is called MEMS (Micro-Electro-Mechanical Systems). The MEMS technique results in the integration of the mechanical mechanism with the necessary electronic circuit on single silicon chip, similar to the method used to produce computer chips. Using MEMS to produce a device reduces both the cost and size of the product, compared to similar devices made with conventional methods. MEMS is a stepping stone to NEMS or Nano Electro Mechanical Systems. NEMS products are being made by few companies, and will take over as the standard, once manufactures make the investment in the equipment needed to produce nano-sized features.

Molecule Manufacturing : If you're a Star Trek fan, you remember the replicator, a device that could produce anything from a space age guitar to a cup of Earl Grey tea. Your favourite character just programmed the replicator, and whatever he or she wanted appeared. Researchers are working on developing a method called molecular manufacturing that may someday make the Star Trek replicator a reality. The gadget these folks envision is called a molecular fabricator; this device would use tiny manipulators to position atoms and molecules to build an object as complex as a desktop computer. Researchers believe that raw materials can be used to almost any inanimate object using this method.

Medicine : Researchers are developing customised nanoparticle size of molecules that can deliver drugs directly to diseased cells in the body. When it's perfected, this method should greatly reduce the damage treatment such as chemotherapy, does to a patient's healthy cells. Nanomedicine refers to future developments in medicine that will be based on the ability to build nanorobots. In the future these nanorobots could actually be programmed to repair specific diseased cells, functioning in a similar way to antibodies in our natural healing processes.

Electronics : Nanotechnology holds some answers for how we might increase the capabilities of electronic devices while we reduce their weight and power consumption.

Space : Nanotechnology may hold the key to making space-flight more practical. Advancement in nanomaterials make lightweight solar sails and a cable for the space elevator possible. By significantly reducing the amount of rocket fuel required, these advances could lower the cost of reaching orbit and travelling in space.

Food : Nanotechnology is having an impact on several aspects of food science, from how food is grown to how it is packaged. Companies are developing nanomaterials that will make a difference not only in the taste of food, but also in food safety, and the health benefits that food delivers.

Fuel Cells : Nanotechnology is being used to reduce the cost of catalysts used in fuel cells to produce hydrogen ions from fuel such as methanol and to improve the efficiency of membranes used in fuel cells to separate hydrogen ions from other gases as oxygen.

Solar Cells : Researchers have developed nanotech solar cells that can be manufactured at significantly lower cost than conventional solar cells.

Batteries : Work is currently being done for developing batteries using nanomaterials. One such battery will be as good as new even after remaining on the shelf for decades. Another battery can be recharged significantly faster than conventional batteries.

Fuels : Nanotechnology can address the shortage of fossil fuels such as diesel and gasoline by making the production of fuels from low grade raw materials economical, increasing the efficiency of engines, and making the production of fuels from normal raw materials more efficient.

Better Air Quality : Nanotechnology can improve the performance of catalysts used to transform fumes escaping from cars or industrial plants into harmless gases. That is because catalysts made from nanoparticles have a greater surface area to interact with the reacting chemicals than the same quantity of catalysts comprising larger particles. The larger surface area allows more chemicals to interact with the catalyst simultaneously, which makes the catalysts more effective.

Cleaner Water : Nanotechnology is being used to develop solutions to three very different problems in water quality. One challenge is the removal of industrial wastes, such as a cleaning solvent called TCE, from groundwater. Nanoparticles can be used to convert the contaminating chemical, through a chemical reaction into harmless material. Studies have shown that this method can be used successfully to reach contaminates dispersed in underground ponds and treat them at much lower cost than conventional methods which require pumping the water out of the ground for treatment.

Chemical Sensors : Nanotechnology can

enable sensors to detect very small amounts of chemical vapours. Various types of detecting elements, such as carbon nanotubes, zinc oxide nanowires or palladium nanoparticles can be used in nanotechnology-based sensors. Because of the small size of nanotubes, nanowires, or nanoparticles, a few gas molecules are sufficient to change the electrical properties of the sensing elements. This allows the detection of a very low concentration of chemical vapours.

Sports Goods : If you're a tennis or golf player, you'll be glad to hear that even sports goods has wandered into the nanotechnology applications in the sports arena include increasing the strength of tennis racquets, filling any imperfections in club shaft materials and reducing the rate at which air leaks from tennis balls.

Discussion : Hold a discussion in the class about the basic concepts of nanotechnology, which might include issues like :

- You learned in this introduction that scientists had to imagine the characteristics of nanoparticles for years before they developed special microscopes that allowed them to see them. What would it be like to work with a material you can't see? Are there other fields of science where you work with things you can't see? (Radio waves, gravity, etc.)
- Which is bigger : A nanoparticle, an atom, or a molecule? Discuss the fact that, depending on the composition and number of atoms in a molecule, it can vary from a nanometre in diametre to hundreds of nanometres in length. Similarly, different types of atoms may have diametres ranging from a tenth of nanometre to 5 tenths of a nanometre. Nanoparticles also vary in size, ranging up to 100 nanometres. All of these can be measured in nanometres, a measurement with a constant size of one billionth of a metre.

Explore an Application of Nanotechnology

Discussion : Some scientific fields focus on one type of material or process, such as biology that focuses on living organisms and metreeology that focuses on the weather. What does nanotechnology focus on? Remind the students of the definition of nanotech nanotechnology; this study of structures of small size can be applied in just about any field. Nanotechnology is currently being used in medicine, the environment, to add strength to materials such as fabrics, space flight, and so on.

Reading : Have students search over as many processes of information as possible including the internet and pick few pages to read. Encourage them to follow links on the site for additional information, if they find it interesting. Have them create a brief report about what they have read and present it to the class.

The Future of Nanotechnology

Explain that nanotechnology has the potential to be a disruptive technology, meaning that it could cause extreme change in our society that could have a wide range of consequences. An example of this would be the industrial revolution, which changed the economy of most of our cultures from agrarian to manufacturing based.

Discussion : Pick one of these topics:

- The molecular replicator, once developed, could allow people to simply produce many items they need themselves with no need for a company to manufacture those products. What would this do to our economy as we know it today? What if everybody could produce their own clothing, iPod, and shoes? Would it help poorer people or would it put people out of work? How would the world change?

- In the world of medicine nanotechnology could change the human lifespan. Repairs at the cellular level could stop and even reverse aging. If everybody could live hundreds of years, what would happen to our world? Would only an elite few get such treatment and what consequences would that have? If nobody ever died, would people have to stop having children to avoid overpopulation? What would that mean to our society?

One can hold a discussion with the entire class, or break up into smaller groups with some groups making an argument for the benefits of these changes, and the other groups arguing the case that such changes would bring more harm than good to our society.

Optional Activity : Hold debates between the groups on the above discussion topics.

Wrap up the lesson by pointing out that nanotechnology offers great potential for advancement, and that, as with any scientific breakthrough, it also raises ethical and societal questions.

The following is a model syllabus on nanotechnology that it can be most suitable for adoption at senior secondary level. The proposed syllabus is conceived for four semesters after class Xth. In semester format one can pursue issues more deeply and explore a wider variety of questions.

Nanoscience I

- Biology
- Algebra
- Computer Literacy
- Writing and Research
  — Cell Structure
  — DNA Extraction
  — Gel Electrophoresis
  — Enzyme and Protein Structures
  — Tagging methods

Nanoscience II

- Chemistry
- Physics
- Mathematics
- Communication
  — Periodic Table
  — Molecules
  — Compounds
  — Physical properties
  — Electrical properties
  — Band structures
  — Computer Simulation
  — Basics of modelling programmes
  — Input requirement
  — Reliability
  — Variations
- Observational Internship

Nanoscience III

- Nanoelectronics
  — Serve as an introduction to electrical structures
  — Processor and memory device design and fabrication
  — Emerging technologies: quantum, photonics, nanowires, molecular
- Nanobiotechnology
  — Serve as an introduction to the field
  — Energy production and enzymatic processes
  — Protein interactions
- Nanomaterials
  — Introduction to material properties and manufacturing methodologies
  — Adhesion, tension, friction, viscosity, etc.,
  — Impact of manufacturing and operational environments

Nanoscience IV

- Advanced Fundamental Courses
- Micro and Nano Fabrication
- Thin Film Deposition
- Introduction to Materials Characterisation
- Principles and Applications of Nanobiotechnology
- Industry Internship

Picture on page 33 : Tiny nanogears may one day move microscopic machines through the human body in search of disease. (Source: www. highlighthealth.com/.../2009/10/telomere.gif)

ENERGY AND ELECTRONIC CHARGE CONSERVATION DURING ALPHA AND BETA EMISSION

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Introduction

In 1986, Antoine Henri Becquerel, a French physicist, while working on phosphorescent materials such as uranium salts, found that they emit radiations spontaneously. It was later established that a magnetic or an electric field splits such radiations into three beams. These radiations have been named after the first three letters of the Greek alphabet, i.e., alpha (α), beta (β) and gamma (γ). The first two radiations are corpuscles in nature so they are called particles whereas the third, being electromagnetic radiation, is called a ray. The elements, which spontaneously emit such type of radiations, are called radioactive elements and the phenomenon is known as radioactivity. For discovery of these radiations, Becquerel received Nobel Prize for Physics jointly with Marie Curie and Pierre Curie in 1903.

Before going into detail of the phenomena it is imperative to understand the structure of an atom. An atom consists of a positively charged central core, the nucleus, and negatively charged electrons which revolve round the nucleus in fixed orbits. The nucleus contains positively charged particles protons and neutral particles neutrons. Either a proton or a neutron is called a nucleon. In the normal state of the atom, the number of protons is equal to the number of electrons, so that the atom is electrically neutral. The number of protons is constant and unique to a particular atom and is called the atomic number (Z) whereas the number of protons plus number of neutrons in the nucleus give the mass number (A). Since like charges repel one another, the protons within the nucleus are always trying to push each other apart but they are held together by the attractive nuclear forces resulting from the combined protons and neutrons. When there is imbalance between the attractive nuclear forces and the electrostatic repulsive forces (Coulomb replusion), the nucleus does not have enough binding energy to hold permanently the nucleons together, as a result of which it becomes unstable. In unstable nuclei the binding energy per nucleon is very low. It is found that all nuclei with $Z > 83$ and $A \geq 210$ achieve greater stability by emitting spontaneously one or more α– particles (helium – 4 nuclei), called

α– particles (helium –4 nuclei), called α– emission. Again, it is observed that in stable nuclei the ratio of neutron number to proton number $\left(\frac{n}{p}\right)$ is usually between 1 and 1.5 (excluding the hydrogen nucleus which consists of only one proton) (Marmier, 1969). So the nucleus becomes unstable when it possesses either a higher $\frac{n}{p}$ value than that for stable nuclei by containing excess neutrons or a lower $\frac{n}{p}$ value by containing excess protons. In the former case it emits an electron, called β^-– emission, and in the latter case it emits a positron called β^+– emission, to dissipate excess energy.

(A) Alpha Emission

After α– emission the original atom transforms into a new atom of some other element whose proton and neutron numbers each decreases by by 4 and 2 units respectively. In general this is represented as

$$ {}^{A}_{Z}X \longrightarrow {}^{A-4}_{Z-2}Y + {}^{4}_{2}He^{++} + Q \qquad (1) $$

where X and Y are symbols for the parent and the residual atoms respectively and Q, the decay energy, is shared by the kinetic energy of the α– particle and the recoil energy of the resulting atom. From equation (1), it is clear that α– emission is only possible if Q value is positive.

For example,

$$ {}^{238}_{92}U \longrightarrow {}^{234}_{90}Th + {}^{4}_{2}He^{++} + 4.19\ MeV, \qquad (2) $$

where mega electron volt (MeV) is the unit of energy (1 eV = 1.6×10^{-19} joule).

(i) Conservation of Energy during α–Emission

In equation (2), sum of masses of the products (a thorium-234 and an α-particle) is less than mass of the parent atom. The decrease in mass is converted to energy according to Einstein's mass energy equivalence relation $E = mc^2$, where E is the total energy, m the effective mass and c the velocity of light in free space ($c = 3 \times 10^8$ m/s). This energy is shared by the residual thorium atom and the emitted α–particle. Since α–particle is quite lighter than thorium atom, most of the energy released is carried by the α-particle.

(ii) Conservation of Electronic Charge during α–Emission

It appears from equation (2) that the electronic charge is unbalanced although proton number is conserved in the equation. If we count the number of protons, neutrons and electrons present in the parent and the residual atoms of equation (2), we find that the parent atom has 92 protons,
146 neutrons and 92 electrons whereas the residual atom will have 90 protons, 144 neutrons and 92 electrons as an α–particle contains two protons and two nuetrons only. This reveals that the residual atom has excess of two electrons compared to its total number of protons. Thus it is an ion. It is observed that at the time of decay the residual atom as well as the α–particle is in ionic form but subsequently they acquire neutrality. The question arises what happens to these extra electrons in the residual thorium atom? It appears that a continuous range of values, ranging, from zero up to some maximum

value rather than a discrete value (Beiser, 2006; Evans, 1978). This is in apparent contradiction to the law of conservation of energy. It has been a great puzzle. A second problem is that the emitted electron does not usually travel in a direction opposite to that of the residual atom as in a two-body decay, which shows an apparent violation of conservation of linear momentum. A third problem is that spins of the neutron, proton and electron (in units of *h/2p*) are all ½, so the spins (and hence also angular momentum) is not conserved in equation (3).

All these apparent discrepencies were accounted for Wolfgang Pauli in 1931 (Beiser, 2006; Evans, 1978). He suggested that in addition to electron, another extremely light particle is also emitted and these particles share the energy available in $^{14}_{7}N$. This suggestion explains the observed continuous energy spectrum of the emitted electrons. This new particle has to be electrically neutral to conserve charge and has spin of (1/2) (h/2π) to conserve angular momentum. Enrico Fermi has named this particle as 'neutrino' ("little neutral one" in Italian). Later it was recognised as electron-antineutrino ($\overline{\nu}_e$) to conserve lepton number which must be conserved in weak interaction that causes beta emission. The lepton number is experimentally determinable just like electric charge and its value is +1 for leptons such as electron, muon (μ), tau (τ) and their associated neutrinos (ν_e , ν_μ and ν_τ) and –1 for antileptons. The decay equation (3) can thus be modified as

$$^{1}_{0}n \longrightarrow {}^{1}_{1}p + {}^{0}_{-1}e + \overline{\nu}_e + Q \qquad (5)$$

The existence of neutrinos has been experimentally observed by Cowan and Reines (Cowan *et al.*, 1956). The general transformation equation describing β^- emission becomes

$$^{A}_{Z}X \longrightarrow {}^{A}_{Z+1}Y + {}^{0}_{-1}e + \overline{\nu}_e + Q \qquad (6)$$

The continuous energy carried by the electron can be explained in the following way. In β^--emission, electron and electron-antineutrino are ejected out of the nucleus and share the maximum energy of the emission in all proportions with each other, as they are much lighter than the residual atom. When $\overline{\nu}_e$ does not get any energy, the electron carries all the energy and in case $\overline{\nu}_e$ grabs whole of the energy, the electron is left without any energy. Further, the conservation of linear and angular momenta is also satisfied because $\overline{\nu}_e$'s linear and angular momenta exactly balance those of the emitted electron and the residual atom as in three-body decay.

A fundamental level, each neutron consists of one 'up' (u) quark and two 'down' (d) quarks whereas each proton cunts of two u-quarks and one d-quark. The u-quark carries an amount of +2/3 electronic charge and the d-quark carries an amount of –1/3 electronic charge. So, equation (5) is due to the conversion of a d-quark into a u-quark by emission of a W^- boson (Fig.1) due to the weak interaction (Griffiths, 1987). The W^- boson subsequently decays into an electron and an electron-antineutrino. So the transformation of a neutron into a proton takes place with the emission of an electron for charge conservation and an electron-antineutrino for energy and momentum conservation.

The schematic diagram is given below :

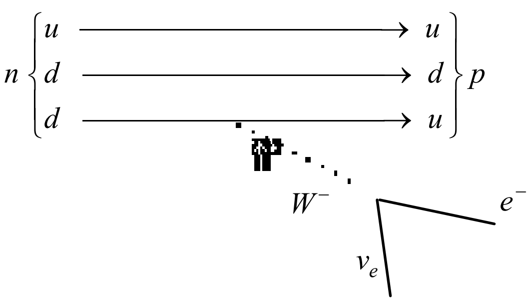

Figure 1: Conversion of a neutron into a proton

(ii) β⁺-Emission

A positron is emitted from a nucleus in this case, this is possible only when a proton is converted into a neutron in the nucleus. in order to conserve energy, linear and angular momenta, an electron-neutrino (ν_e) is also emitted. Thus,

$$ {}^{1}_{1}p \longrightarrow {}^{1}_{0}n + {}^{0}_{+1}e + \nu_e + Q \qquad (7)$$

The general transformation equation of β⁺-emision can be written as

$$ {}^{A}_{Z}X \longrightarrow {}_{Z-1}{}^{A}Y + {}^{0}_{+1}e + \nu_e + Q \qquad (8)$$

Conservation of Energy during β⁺-Emission

Now the pertinent question is, 'how a proton which is smaller in mass than a neutron can convert into a neutron and other particles'. Actually, a free proton, i.e., a proton outside the nucleus, cannot decay into a neutron, as there will be violation of energy conservation. This also explains that why a free proton is stable whereas a free neutron is unstable (half-life =10 min16 s) (Beiser, 2006). However, this is possible inside a nucleus as proton gets energy from the nucleus and is converted into a neutron by emitting a positron and an electron-neutrino. This can be written as

$$ \text{energy} + {}^{1}_{1}p \longrightarrow {}^{1}_{0}n + {}^{0}_{+1}e + \nu_e + Q \qquad (9)$$

Since proton number decreases by one and neutron number increases by one, β⁺-emission helps to increase $\frac{n}{p}$ value.

Conservation of Electronic Charge during Beta (β^{+}) Emission

Consider a tritium decay which spontaneously gives helium –3 by emitting an electron and an electron-antineutrino as follows:

$$ {}^{3}_{1}H \longrightarrow {}^{3}_{2}He + {}^{0}_{-1}e + \overline{\nu}_e + 18.6 KeV \qquad (10)$$

The number of protons, neutrons and electrons present in a tritium atom is one, two and one respectively whereas the residual helium–3 atom will have two protons, one neutron and one electron. So the residual atom has insufficient number of electrons to balance its number of protons, i.e., it becomes helium ion (He⁺). Similarly in β⁺-emission the residual atom will have one electron more. This implies that the residual atoms in both types of decay processes are ions at the time of decay. It has been observed in early experiments (Linder and Christian, 1952) that a neutral radioactive element gets charged after emitting beta particles and gradually becomes neutral. It appears that the positively charged helium ion subsequently tries to acquire an extra electron from one of the neighbouring atoms to become neutral. And in β^+-emission, the negatively charged residual atom emits an electron to the surrounding to become neutral. Again, in case of β^--emission, the emitted electron encounters numerous collisions and finally stops. Then, it usually attaches to an atom. On the other hand, in β^+-emission, the emitted positron (antiparticle) immediately collides with electron (particle) of the surrounding produces energy which is carried away by two photons of gamma radiation.

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THE ROLE OF METACOGNITION IN LEARNING AND TEACHING OF PHYSICS

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This article provides a brief overview of the theory of metacognition and its role in learning and teaching. The metacognitive knowledge of strategy, task and personal variables enables students to perform better and learn more. The instructional strategies that facilitate the construction of knowledge are discussed. Metacognitive strategies for physics learning and teaching are given.

Introduction

Metacognitive knowledge involves knowledge about cognition in general, as well as awareness of and knowledge about one's own cognition. The research on learning emphasis on helping students become more knowledgeable of and responsible for their own cognition and thinking [Flavell, J.1979 , DeJager *et al.* 2005]. Students become more aware of their own thinking as well as more knowledgeable about cognition in general. Furthermore, as they act on this awareness they tend to learn better [Eylon, B. S. and Reif, F.1984]. The labels for this general developmental trend vary from theory to theory, but they include the development of metacognitive knowledge, metacognitive awareness, self-awareness, self-reflection, and self-regulation. Although there are many definitions and models of metacognition, an important distinction is one between (a) knowledge of cognition (Metacognitive knowledge) and (b) the processes involving the monitoring, control, and regulation of cognition. Metacognitive knowledge includes knowledge of general strategies that might be used for different tasks, knowledge of the conditions under which these strategies might be used, knowledge of the extent to which the strategies are effective, and knowledge of the self. Metacognitive control and self regulatory processes are cognitive processes that learners use to monitor, control, and regulate their cognition and learning. The metacognitive and self-regulatory processes are well represented in tasks such as checking, planning, and generating. Accordingly, on the knowledge dimension, 'metacognitive knowledge' categories refer only to knowledge of cognitive strategies, not the actual use of those strategies.

Three Types of Metacognitive Knowledge

In a classic article on metacognition, Flavell (1979) suggested that metacognition include knowledge of strategy, task, and person variables. Flavell's model encourages students to consider how each variable affects their own learning processes. Metacognitive knowledge could be categorized under three heads - Strategic Knowledge, Knowledge about cognitive task and Self-knowledge.

Strategic Knowledge

Strategic knowledge includes knowledge of the various strategies students might use to memorise material, to extract meaning from text, and to comprehend what they hear in classrooms or what they read in books and other course materials. Although there are a large number of different learning strategies, they can be grouped into three general categories: rehearsal, elaboration, and organisational [Isaacson and Fujita 2006]. Rehearsal strategies refer to the strategy of repeating words or terms to be remembered over and over to oneself, generally not the most effective strategy for learning more complex cognitive processes. In contrast, elaboration strategies include various mnemonics for memory tasks, as well strategies such as summarising, paraphrasing, and selecting main ideas from texts. The elaboration strategies result in deeper processing of the material to be learned and lead to better comprehension and learning than the rehearsal strategies. Finally, organisational strategies include various forms of outlining, concept mapping, and note taking, where the student makes connections between and among content elements. Like elaboration strategies, these organisational strategies usually result in better comprehension and learning than rehearsal strategies.

Students can have knowledge of various metacognitive strategies that will be useful to them in planning, monitoring, and regulating their learning and thinking. These strategies include the ways in which individuals plan their cognition (e.g., set subgoals), monitor their cognition (e.g., ask themselves questions as they read a piece of text; check their answer to a problem in mathematics), and regulate their cognition.

Knowledge about cognitive task

In addition to knowledge about various strategies, individuals also accumulate knowledge about different cognitive tasks. In recall task, the individual must actively search memory and retrieve the relevant information; while in the recognition task, the emphasis is on discriminating among alternatives and selecting the appropriate answer. As students develop their knowledge of different learning and thinking strategies and their use; this knowledge reflects the "what" and "how" of the different strategies. However, this knowledge may not be enough for developing expertise in learning. Students also must develop some knowledge about the "when" and "why" of using these strategies appropriately [Rajkumar 200], Shulman 1986]. Because not all strategies are appropriate for every situation, the learner must develop some knowledge of the different conditions and tasks where the different strategies could be used most appropriately.

Self-knowledge

Along with knowledge of different strategies and knowledge of cognitive tasks, Flavell (1979) proposed that self-knowledge was an important component of metacognition. Self-knowledge includes knowledge of one's strengths and weaknesses. This self-awareness of the breadth and depth of one's own knowledge base is an important aspect of self-knowledge. Finally, individuals need to be aware of the different types of strategies they are likely to rely on in different situations. An awareness that one relies more on a particular strategy when there may be better alternative adaptive strategies for the task, could lead to the possibility of a change in strategy use.

Implications for learning and teaching

Metacognitive knowledge can play an important role in student learning and, by implication, in the ways students are taught and assessed in the classroom [Nuthall, G.1999]. First, as previously noted, metacognitive knowledge of strategies and tasks, as well as self-knowledge, is linked to how students will learn and perform in the classroom. Students who know about the different kinds of strategies for learning, thinking, and problem solving are more likely be using them. After all, if students do not know of a strategy, they will not be able to use it. Students who do know about different strategies for memory tasks, for example, are more likely to use them to recall relevant information. Similarly, students who know about different learning strategies are more likely to use them while studying. And, students who know about general strategies for thinking and problem solving are more likely to use them when confronting different classroom tasks. Metacognitive knowledge of all these different strategies enables students to perform better and learn more. Many teachers assume that some students will be able to acquire metacognitive knowledge on their own, while others lack the ability to do so. Of course, some students do acquire metacognitive knowledge through experience and with age, but many more fail to do so. It is not expected that teachers would teach for metacognitive knowledge in separate courses or separate units.

It is more important that metacognitive knowledge is embedded within the usual content-driven lessons in different subject areas. General strategies for thinking and problem solving can be taught in the context of English, mathematics, science, social studies, arts, music, and physical education courses. Science teachers, for example, can teach general scientific methods and procedures, but learning will likely be more effective when it is tied to specific science content, not as an abstract idea. The key is that teachers plan to include some goals for teaching metacognitive knowledge in their regular unit planning, and then actually try to teach and assess for the use of this type of knowledge as they teach other content knowledge. One of the most important aspects of teaching for metacognitive knowledge is the explicit labelling of it for students.

Implication of physics learning

Metacognitive strategies refer to strategies for helping learners become more aware of themselves as learners, and include ability to monitor one's understanding through self-regulation; ability to plan, monitor success and correct errors when desirable; and ability to assess one's readiness for high level performance in the field one is studying [Mestre and Touger 1989]. Reflecting about one's own learning is a major component of metacognition, and does not occur naturally in the physics classroom, due to lack of opportunity and also because instructors often do not emphasize its importance. It is common to hear physics students comment,'I am stuck on this problem',but when asked for more specificity about this condition of 'stuckness', students are at a loss to describe what we are sticking on this problem that has them stuck, and often just repeat that they are just stuck and can't proceed. If during instruction, we were to take the time to suggest why, and how, students should reflect about their learning, there would be fewer incidents of the 'stuck' condition, since students would be able to identify what they are missing that would allow them to proceed. The contemporary view of learning is that individuals actively construct the knowledge they possess.

Constructing knowledge is a lifelong, effortful process requiring significant mental engagement from the learner. In contrast to the 'absorbing knowledge in ready-to-use form from a teacher or textbook' view of learning, the 'constructing knowledge' view has two important implications for teaching. One is that the knowledge that individuals already possess affects their ability to learn new knowledge. When new knowledge conflicts with resident knowledge, the new knowledge will not make any sense to the learner, and is often constructed (or accommodated) in ways that are not optimal for long-term recall or for application in problem-solving contexts [Redish 2000].

The second implication is that instructional strategies that facilitate the construction of knowledge should be favoured over those that do not. Sometimes this statement is interpreted to mean that we should abandon all lecturing and adopt instructional strategies where students are actively engaged in their learning. Lecturing could be a very effective method for helping students learn, but wholesale lecturing is not an effective means of getting the majority of students engaged in constructing knowledge during class-room instruction. Hence, instructional approaches where students are discussing physics, doing physics, teaching each other physics and offering problem solution strategies for evaluation by peers will facilitate the construction of physics knowledge.

Implication of physics teaching

Largely missing from science classrooms, especially large lecture courses, is formative assessment intended to provide feedback to both students and instructors, so that students have an opportunity to revise and improve the quality of their thinking and instructors can tailor instruction appropriately. The age-old technique of asking a question to the class, and asking for a show of hands has been tried by most, but does not work well since few students participate in the hand-raising largely due to lack of anonymity. In classes having fewer number of students it is not difficult to shape teaching so that two-way communication takes place between the teacher and the student. For example, one very effective method of teaching physics to having classes with fewer number of students, perfected by Resnick (1983) involves class-wise discussions led by the teacher. Students offer their reasoning for evaluation by the other classmates and by the teacher, with the instructional format taking somewhat the form of a debate among students, with the instructor moderating the discussion and leading it to desired certain direction by posing carefully crafted questions. In classes with large enrollment, the advent of classroom communication systems allows the incorporation of a workshop atmosphere, with students working collaboratively on conceptual or quantitative problems, entering answers electronically via calculators, and viewing the response of entire class's in the form of histogram form for discussion [Mestre *et.al.* 1989, Redish 2000]. With this approach, the histogram serves as a springboard for a class-wise discussion in which students volunteer the reasoning that led to particular answers and the rest of the class evaluates the arguments. The teacher moderates, making sure that the discussion leads to appropriate understanding.

Metacognitive strategies in Physics teaching

The research reviewed above carries important implications for how instruction for teachers should be structured. In this section I provide a list of desirable attributes for physics courses suggested by research on learning.

- Construction, and sense-making, of physics knowledge should be encouraged.
- The teaching of content should be a central focus.
- Ample opportunities should be available for learning 'the process of doing science'.
- Ample opportunities should be provided for students to apply their knowledge flexibly across multiple contexts.
- Helping students organise content knowledge according to some hierarchy should be a priority.
- Qualitative reasoning based on physics concepts should be encouraged.
- Metacognitive strategies should be taught to students.
- Formative assessment should be used frequently to monitor students understanding and to help tailor instruction to meet students' needs.
- Teachers must provide students with opportunities to practice strategies they have been taught.

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STUDENTS' SCIENCE RELATED EXPERIENCES, INTEREST IN SCIENCE TOPICS AND THEIR INTERRELATION

SOME IMPLICATIONS

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There are mounting evidences of decline in the interest of young people in pursuing science. The policy report of ninth meeting of Global Science Forum (2003) found that there is steady decline in the number of students in science and technology. In India also, there is a similar trend of decline in interest to pursue study of science interest. National Science Survey (Shukla, 2005) has shown that interest in science as well as satisfaction with the quality of Science teaching declined as the age increased. One cannot take the decline in interest in science lightly. Surveys across the globe suggest that lack of interest in science is mainly due to science being less intrinsically motivating (Global Science Forum, 2003; National Science Survey, Shukla, 2005), nature of science being cutoff from real world and its content being overloaded with matters unrelated to the life of students (Hill and Wheeler, 1991; Osborne and Collins, 2001). One way of making science relevant is to base science on experiences in which pupils are interested and those that can find applications in real life.

Recent studies on interest in science in India show that there is a shift away from science at the plus-two and under-graduate level (Patil, 2003). As interest in science develops quite early in life (Gardner, 1975), decline in interest in science in later years of life can be tackled to a certain extent by providing all the factors conducive to the development of interest in science interest from quite early years itself. Exploration in the field of influence of out-of-school science experiences on interest in science is not substantial in India.

Present article is based on a study conducted by the authors on 1473 students in 14 upper primary school students in Kozhikode district of Kerala.

Attemptwas made to know the science-related activities that children themselves choose without any external suggestion and the resultant influence these activities have on interest in the topics that they learn in their science classes. The following are the broad findings, conclusions and the implications derived from the study.

Extent and Nature of Science Related Experiences that Pupil Bring into Classroom

The extent of out-of-school science experiences of upper primary school pupils is moderate in nature. Pupils havemore out-of-school experiences in biology compared to those in physics and chemistry. This can be attributed to many a reasons. Biology experiences are quite evident and are quick to arouse curiosity of young children. In addition, experiences related to health and hygiene is a part of one's daily life. In biology, maximum experience is through collection. Most children collect leaves, feathers etc. for aesthetic purpose. It is quite strange that pupil derive least experience through observation. Theoretically, one can get lots of biological experience through observation. Nevertheless, active nature of young children maynot let them remain satisfied with observation alone, which is a passive process.

Out-of-school chemistry experiences are comparatively less among children. This may be because these experiences (e.g. different types of taste and odour) are so common and so implicit that children more often do not give special attention to them. That is, they experience them but they do not consider them as on 'experience'. Observations and activities are comparatively more in chemistry. This is quite natural as rapid changes in the colour of things, domestic activities like mixing liquid blue in water, making pickles etc. are easily available to all. The extent of experimentation is comparatively low. Observations like removing paint using kerosene removing nail polish, making transparencies or printing of are rarely associated with applications of chemistry.

The extent of out-of-school experiences related to concepts of physics lie in between that of biology and chemistry. Physics experiences are mainly through observations. Children observe the sky, weather, shadows, etc rarely out of curiosity or for their aesthetic impact and often do not count it as an experience related to science. The least amount of experience is from experimentation. This is again strange, as experiences like melting of ice, changes in length of shadow etc. are quite popular among young children. One reason for this could be that we rarely understand or project science as activity of human beings as an attempt to understand nature and natural phenomena. It may be that children derive more experience from vicarious sources than from direct ones.

Boys have more out-of-school experiences in physics while girls have them in chemistry

The extent and nature of out-of-school science experiences differ among boys and girls. Boys usually have more experiences than girls. It may be that boys get more opportunities for out-door activities. The difference is mainly due to the advantage of boys in relation to out-of-school relating to physics experiences. This finding is similar to those from other parts of the world (Farenga and Joyce, 1997; Sjoberg, 2000; Christidou, 2006). Boys, world over, get more involved in hands-on physical activities like repairing things and opening up toys or other things to know the parts, activities typically considered as male-stereotype ones. It is a part of the sex-role expectations of the society (Johnson, 1987; Farenga and Joyce, 1997). Girls usually have more chemistry related out-of-school observations and activity than the boys. Domestic surroundings give easy access to chemistry related experiences like making of pickles observing, changing in colour of fruits and vegetables, say, apples. Compared to girls, boys indulge more in biology related activities like listening to the sound of birds, maintaining aquarium, rearing animals. Agriculture, fishing and similar other activities are typical male dominated activities in developing countries (Sjoberg, 2000). Biological activities also include those related to health and hygiene. Due to the increased interest in fitness in present times, boys indulge more in health care. Compared to boys, girls indulge more in collecting items like leaves and feathers, which can be for aesthetic purpose. Generally, boys, compared to girls, indulge more in active tasks while girls, compared to boys, indulge more in passive tasks like collection. Science is doing; hence, boys who indulge more in active tasks will naturally have higher extent of experiences in science.

Urban pupils excel rural pupils in out-of-school science experiences

Urban and rural pupils differ in their out-of-school science experiences with urban pupils having more experiences than rural pupils especially in Biology and Physics. The reason can be the difference in opportunities. Rural pupils get opportunities for nature-related direct experiences. Even though this is less for urban pupils, they receive indirect experiences through a visit to parks, zoological gardens, planetarium etc. Urban pupils have the added benefit of getting more vicarious experiences through computers and internet that can compensate for the lack of direct experiences.

Pupils in aided schools lag behind those in government and unaided schools in out-of-school science experiences

Type of management also influences the extent and nature of out-of-school science experiences. Government school pupils have more experience especially in observations related to biology besides physics, biology and chemistry related activities as compared to children from both aided and unaided schools. Biological activities are nature-related which are accessible to all but physics related activities require mechanical and technological facilities, which are comparatively available more to pupils in unaided schools. They have more opportunity to be familiar with television programmes, computers and internet mainly due to their more affluent background. Among the three groups, pupils from aided schools are likely to have the least experiences, They may not be as familiar with technological activities in comparison to pupil from unaided schools, due to the difference in the domestic and school environment. Nevertheless, they may not be getting as much freedom as children in government schools get to explore their surroundings, due to the protective and restrictive nature in middle class families in third world countries. Further, research is required to explore how out-of-school experiences vary for pupils in different types of schools.

Interest in Science Topics among Upper Primary Pupils

The extent of interest in science of upper primary pupils is relatively high, which is a good indication, as science is an inevitable raw material of technology. Pupils have comparatively more interest in biology and physics. Interest in biology is due to pupils' desire to know about themselves and other living forms in their surroundings. Physics can never remain behind in modern world, as it is the basis for many popular professional courses like Engineering and Computer applications. Moreover, origin of universe, space explorations etc. have always been a challenge to man, and to young curious minds. Study conducted elsewhere (Borrows, 2004) also shows lesser preference for chemistry among pupils. The reason cited is that pupils consider chemistry as something that happens in the laboratories. Topics like acids, recycling of wastes, fertilisers, etc. may give the idea that these are 'jobs' to be done in factories alone thereby reducing their appeal.

Girls are more interested in biology and chemistry while boys are more interested in physics

The extent of interest in science is more for girls, owing mainly due to their higher interest in biology and chemistry. Increased interest of girls in biology is similar to the findings in previous researches (Gardner, 1975; Sjoberg, 2000; Uitto *et al*, 2006). The reason cited is that girls are more interested in people and life oriented aspects of science like biology (Miller *et al*, 2006). The same reason is applicable to the increased interest in chemistry as topics like production of cooking gas, food preservation, preparation of medicine etc. deal with chemistry that influences lives of people. Boys are more interested in physics. This finding also has support of previous researches (Tsabari and Yarden, 2005; Christidou, 2006). Physics topics deal with abstract concepts that appeal girls less (Tsabari and Yarden, 2005). Moreover, boys have more experiences in physics; experiences have an influence on interest (Johnson, 1987; Sjoberg, 2000).

Urban pupils have more interest in science

Urban pupils are more interested in all the three fields of science than the rural pupils. This suggests societal influence on interest in science. Urban pupils receive latest information through media, computers and internet at home. Further, schools and computer institutes in urban locality help them develop better understanding about scientific concepts. Better understanding can increase interest in science. Lave and Wenger's (1991) observation of learning as contextualised and shaped by physical, social and political landscape in which it occurs to development of interest can be applied to development of interest in science as well.

Pupils in aided schools have lesser extent of interest in science

Pupils in Government and unaided schools have more interest in science than amongst those in Government aided schools. Difference in interest might partially be due to difference in their experiences in day to day life. Apart from this, school facilities including access to internet and libraries, learning environment, teaching style together with the difference in the social background of the three strata influence their interest. Children in unaided schools, by and large, get better learning facilities, in their school as well as at home, while in government schools they get them through the facilities provided by the government. Children from aided schools remain wanting in both these aspects.

Out-of-School Science Experiences Contributes to Interest in Science

The relationship between out-of-school science experiences and interest in science is positive in all fields of science and in all categories of experiences. This also is in agreement with earlier studies (Joyce and Farenga, 1999; Uitto et al, 2006, Zoldozoa, 2006). The relationship is substantial in biology while in physics and chemistry, it is comparatively low. This indicates that influence of experiences on interest is more in biology than in physics and chemistry. This maybe because biology is more life related. Among the categories of experiences, experimentation has more impact on interest. Experimentation is an act of discovery which in turn nurtures interest.

Gender difference exists in relationship between out-of-school experiences and interest in chemistry

Gender difference is evident only in the extent of relationship between out-of-school chemistry experiences and interest in chemistry with boys exhibiting a stronger corelation than the girls. Even though girls have more experience in chemistry than the boys, they do not develop more interest in chemistry. These experiences, received mainly from domestic surroundings, may not be helping girls to find any learning opportunity in them.

Not only urban pupils have more experiences, but these experiences have higher influence on the development of their interest in science.

The extent of relationship between out-of-school science experiences and interest in science shows locality-based differences. The extent of relationship is stronger for urban pupils in all the three fields of science. Urban pupils have more exposure to academic activities through indirect and vicarious means that enrich the science experiences that they get. This also helps them utilise the experiences better to develop stronger interest in science.

Out-of-school science experiences of pupils from unaided schools have better influence on their interest in science.

The extent of relationship between out-of-school science experiences and interest in science is more for children from unaided schools, than from both aided and government schools. Owing to the interventions and guidance from parents and teachers, students from unaided schools are more orientated towards academics. They have better facilities at school like computer lab, rich libraries that enrich their experiences and give them an opportunity to develop wider areas of interest.

Educational Implications

The findings bring to focus the fact that the nature and extent of out-of-school science experiences and interest in science vary for different strata of population. The study also validated the person-object theory of interest by establishing relationship between pupil's experience and her/his interest. Further, it was revealed that the extent of relationship between out-of-school science experiences and interest in science differed among subsamples. These findings render useful information that can bring about some reformations in the educational scenario.

1. Know about what pupils bring to classroom

One cannot do much to control out-of-school experiences, but knowing about what pupils bring to the classroom will help for providing better educational circumstances. For a constructivist teacher, knowledge of pupils' out-of-school experiences is invaluable as the present experiences are building blocks of the future experiences. Knowing students' experiences also assists in providing those experiences that pupil lack. Evidence of pupils' experiential background can help a teacher to choose those experiences that can result in minimal dissonance with existing experiences. In addition, teachers can know how pupils use science in their daily life. Moreover, what people do is more important than what they merely 'know'.

2. Monitor interest from primary classes

Interest develops very early in life. So monitoring of interest should begin from primary school itself. Interest and attitude that one develops in the lower classes influence their future choices (Lloyd and Contreras, 1984). Leaving nature of interests and their fields unnoticed in the developing stages of a child is detrimental as, no matter how hard we try in the later stages, it would be quite difficult to make her/him get interested and people to appreciate science. Identifying pupils' diverse interests helps to nurture interest as well as to find innovative means to make those fields of science in which they lack interest appealing. This proves helpful to alleviate transitional problems as they reach secondary schools with diversified science curriculum.

3. Relate classroom chemistry with child's life

An analysis of the extent of experiences and interest showed that children generally have lesser extent of experience as well as interest in chemistry. Making children realise that chemistry is something that is going on all around and within us will help them see its significance. Extent of experience and interest in biology is relatively high. Pupils need to see that the very essence of biology rests on chemical reactions. This would help them appreciate the significance of chemistry in our lives. Once they understand the utility of chemistry, they will get interested, as pupils need to feel the relevance of a concept in their life to develop interest in it (Qualter, 1993).

4. Never ignore disparity in out-of-school experiences

The disparity in out-of-school experiences is natural as personal choice and the social, cultural and economic background from which pupils come determine these experiences. Still we cannot ignore the disparity in out-of-school experiences, as a substantial positive correlation exists between out-of-school science experiences and interest in science.

5. Girls have to be more accustomed to physics activities

Girls' lesser extent of experience and interest in physics reveals that irrespective of the vast cultural differences, girls all over the world remain elusive once it comes to physics. The reason cited elsewhere – sex-role socialisation- could be the cause for such gender differences in physics in Kerala also. Even in the modern world, there still exist male and female stereotype activities and preferences. Physics is dominated by hands-on mechanical and technological activities, from which girls shy away or are kept away. Girls have to be more accustomed to physics and made aware of the significance of physics lest they remain far behind in the modern techno-savvy world.

6. Revamp rural schools

In the case of rural pupils, the environmental factors allow them to have nature related experiences but when it comes to technological aspects, they do not get the facilities that the affluent urban locale provides. Rural children come to school with an impoverished experiential background. The situation at school is not different. A visit to rural schools can give us a glimpse of the poor infrastructural facilities that pupils have. Disparity between urban and rural schools can do nothing but contribute to the backwardness of rural pupils. The solution lies in a complete revamping of rural schools. More computers and better laboratory facilities, supplemented with trained teachers with enough motivation, frequent educational excursions to places of scientific interest and availability of other resources might be one-step in this direction.

7. Pay special attention to the needs of pupils in Government aided schools

The lack of experience and interest amongst+ pupils in Government aided schools is a serious issue because in Kerala a majority of schools belong to this sector (Department of General Education, Kerala, 2002-03 and 2003-04). Government provides necessary facilities for schools in the public sector whereas unaided schools have the strong support of wealthy managements, trusts and parents. Government aided schools, on the other hand, especially upper primary schools, are wanting in aids from both the government as well as management. This further aggravates the disadvantaged position of pupils in these schools. Therefore, government and management have to pay special attention to the needs of pupils aided schools so that their pupil can be on par with those from government and unaided schools.

8. Personal autonomy is a crucial determiner of interest

The inequality in the magnitude of interest is not a welcome discovery, as over the years, government has been diligently working towards reducing the discrepancy in interest in science between various strata of population. A major landmark in the science education was the introduction of the activity-oriented learning. Nevertheless, there exists a major distinction between out-of-school learning and classroom learning. Most often pupils undertake the activities as part of the curricular requirements. Classroom learning, thus, becomes compulsory and extrinsically motivated. Moreover, all activities are timed and collective. Scope for individual variations is limited. In contrast, out-of-school learning is one of personal choices, giving ample freedom for exploration. The personal autonomy makes out-of-school experiences a crucial determiner of interest, as freedom to make decisions can enhance interest (Hanrahan, 1998). Activity oriented classrooms can be transformed for the better if teachers are willing to accommodate this need of pupils for liberty. Instead of directing them to do exact prescription in the textbook, teacher can enquire about how they would deal with a particular situation. This would not only allow the use of out-of-school experiences but also bring students nearer to diverse ideas that can supplement classroom learning.

9. Using out-of-school experiences individualizes instruction

Out-of-school learning facilitates pupils' inherent nature of individualised way of acquiring information. Using out-of-school experiences in science classrooms thus individualises instruction.

The above discussion on the implications brings on certain recommendations to optimise science learning. Conduct of science enrichment programmes where pupils can implement scientific method under the guidance of resource persons will help create a 'psychological moratorium' – an engaging and psychologically safe chance for learners to experiment with the identity of self as scientist (Erikson, 1968). This not only enhances interest but also gives enriching experiences to students who do not have access to such experiences. Attempt needs to be made to make pupils aware of the task value (Eccles and Wigfield, 1995). Task value indicates the ability of a task to satisfy personal needs, which in turn depends on the interest, importance and utility of the task. Establishing educational guidance cells, especially in rural areas can help to develop awareness about benefits of science thereby nurturing interest in science. As experimental activities are better predicators of interest in science, pupils need more opportunities for experimental activities and club activities.

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COMPUTER AIDED LEARNING

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With the advent and rapid expansion in Information and Communication Technology, the access to higher education is being expanded enormouslyand fundamentallychanging the models of education. Today, with the use of technology, education has become more learner-centric, individualised, interactive and relevant to learner's needs, thus making it truly a life long learning. Higher education can no longer be considered as a campus-based education for students. The arrival of computer and later internet has opened a much wider horizon for education. Computers have takenover every conceivable field of operation today.

Computer Aided Learning (CAL) is based on the integrative approach whereby a lecture or an instruction is not replaced by the computer programme but it is introduced during the course as a learning resource. It refers to the use of computers to aid and support the education and training of the students. It is pedagogy empowered bydigital technology. Computers are beingincreasingly employed for classroom instruction as also for individualised and distance education. Computer- Based Instruction (CBI) is variously known as Computer Aided Learning (CAL) in the U.K. and Computer Assisted Learning (CAI) in the USA. They both refer to on-line direct interactive learning experience through the computer. The synonyms for CALare Internet Based Training (IBT) or web based Training (WBT), Multimedia Learning, Networked Learning and Virtual Education.

CAL is to convey vast amount information in a very short period of time. It is a powerful method of reinforcing concepts and topics first introduced through the text book and discussion in the classroom. CAL empowers us witha powerful tool to comprehend complex concepts. The use of computers in education is basically a vision as a teaching and learning aid, besides it helps to develop computer literacy amongst children. CAL helps to make the teaching-learning process joyful, interesting and easy to understand through audio-visual media. It has potential to improve students' performance by promoting active participation, maintaining attention to tasks and enhancing problem-solving skills.

The psychological bases of using CAL are that learning could take place through hands on activities and by providing opportunity to the learner to construct her/his own knowledge based on one's experiences. The students become an equal partner in the development of the knowledge. It reflects the true spirit of the age old saying, "Tell me and I will forget; Show me and I might remember; But involve me and I will understand.

Instructional Applications of Computers

CAL perhaps provides the best opportunity to the students for self-guided learning. It is self-paced and self-planned, with the students themselves choosing their own paths through the web of information encompassed by the package. It can be done in one of the many different modes of instruction, some of which are:

Tutorial Mode- In this mode, information is presented in small units followed by a question. The student's response is analysed by the computer and an appropriate feedback is provided.

Drill and Practice Mode- In this mode, the learner is provided with a number of graded examples on the concepts and principles learnt earlier. The idea is to develop proficiency and fluency through doing. All the correct responses are reinforced and the incorrect responses are diagnosed and corrected. The computer continues the drill until mastery is achieved by the learner.

In the **Simulation mode**, the learner is presented with scaled-down simulated situations bearing correspondence with the real situations, e.g. simulation of an oscillating pendulum, propagation of waves, flight of an aeroplane, occurrence of a nuclear reaction, etc.

- In the Discovery Mode, the inductive approach to teaching and learning is followed. The learner is encouraged to proceed through trial and error approach, i.e. by solving a given problem, realising, where and how the things went wrong, trying again and finally solving the problem.

In the Gaming Mode, the learner is engaged in playing opposite the computer or a fellow learner. The extent of learning depends on the type of the game. Games on spellings, names of places or general knowledge games are some examples.

Advantages of Computer Aided Learning

The basic tenets of CAL offer the following advantages over other systems of instruction.

- Scalability

  Many aspects of CAL are scalable, particularly when Internet derived technologies are utilised to produce a CAL package. Unlike other educational media, a CAL package is digitally stored. Thus, it may be reproduced without error as many times as required. By providing access to a CAL package over a network many students may use a single resource. Further, if the CAL package is made accessible via an Internet browser then it becomes potentially available to a very wide population of learners using a large number of computers.

- Interactivity

  The importance of interaction to learning was eloquently summarised by Confuscius: "*What I hear I forget. What I see I remember. What I do I remember always*". The nature of CAL lends itself to involving the student with the learning processes with tasks requiring actions as also those dependent on feedback on the action that the student may receive leading to further appropriate tasks. This goal-action-feedback cycle may be followed in a simple series of interactive questions, a complex case study or even a computer simulation of a clinical situation.

- Automation of Assessment

  As a student interacts with a CAL exercise it is possible to keep a record of each interaction on an identifiable log file. This provides a convenient option to check on student performance by checking on the correctness of response to the CAL exercise. Further, by building-up a profile of how a number of users interact with the system it is possible to identify weaknesses in the CAL exercise itself. The automatic logs can thus help decrease both the burdens on assessing students and validating CAL exercises.

- Information interconnectivity

  The information may be interconnected on computers, which allow users to click on highlighted text to jump in a non-sequential manner to related information including pictures, audio and video clips.

- Multimedia

  The incorporation of multimedia elements such as images, audio and video clips in CAL packages provide more than simply enhancing the interest of the learner. Cognitive psychologists suggest that learning is facilitated if the student has to undertake active processing of presented information, "mental roughage". Different individuals learn better in response to different media, and it has been suggested that learning may be improved by providing information in more than one form simultaneously such as animation with sound.

- Students' convenience

  The convenience of the student is taken care of in learning through CAT exercises. Each student receives instruction at his own pace.

- Continuity

  Each student responds continuously as she/he receives instructions.

- Rapid Feedback

  Each student receives rapid feedback. The student gets has/his feedback for the previous content before reaching the next level.

- Division of Content

  All units of learning are broken down into subunits and small elements of learning. The student gains mastery over the first subunit before moving to the next subunit.

- Standardisation of the Content

  The same material is available to a large number of learners over a wide geographical area, which standardises the learning experience whenever the learner logs on.

- Serves a large population

  A single programme can help thousands of students to learn the content practically located anywhere on the globe.

- Nonverbal and Auditory

  It is possible to present the content in nonverbal and auditory form other than the text form.

Physical Obstacles to use of Computer Assisted Learning

- The development of high-tech computer-assisted learning programs is labour intensive, requiring appropriate hardware, backup and frequent upgrading.
- A dedicated information technology staff is necessary to provide practical advice and maintenance of the software and hardware.
- Some people may be less inclined to use electronic resources because of perceived lack of computer literacy.
- There is a lack of adequate basic infrastructure in schools.
- Lack of funds for operations and maintenance makes it difficult to maintain high standards of Computer Assisted Learning.
- Lack of evaluation techniques and results of tools, makes it difficult to know the effectiveness ofthe instruction.
- There are few learning resources for teachers in rural areas.

Teachers related issues

Many a time even if teachers had been trained in the use of computer aided teaching, the integration of ICT in the teaching/learning process is not sustainable. Some common reasons could be:

- teacher overload as they have to prepare the programs for Computer Assisted Learning,
- lack of incentives and motivation for the teachers,
- shortage of trained teachers,
- non-availability of latest Technology Hardware and basic Infrastructure and
- non-availability of proper technical assistance.

Findings of the Research

The researches regarding use of CAL support the following:

- The use of CAL as a supplement to conventional instruction produces higher achievement than the use of conventional instruction alone.
- Research is inconclusive regarding the comparative effectiveness of conventional instruction vis a vis CAL.
- Computer-based education (CAL and other computer applications) produce higher achievement than conventional instruction alone.
- Use of word processors by the students facilitates development of writing skills leading

to higher-quality written work as compared to other methods employed for improving writing skills (paper and pencil, conventional typewriters).

- Students learn material faster with CAL than with conventional instruction alone.
- Students retain what they have learned better with CAL than with conventional instruction alone.
- The use of CAL leads to more positive attitudes toward computers, course content, quality of instruction, school in general, and self-as-learner than the use of conventional instruction alone.
- The use of CAL is associated with other beneficial outcomes, including greater internal locus of control, school attendance, motivation/time-on-task, and student-student cooperation and collaboration than the use of conventional instruction alone.
- CAL is more beneficial for younger students than older ones.
- CAL is more beneficial with lower-achieving students than with higher-achieving ones.
- Economically disadvantaged students benefit more from CAL than students from higher socio-economic backgrounds.
- CAL is more effective for teaching lower-cognitive material than higher-cognitive material.
- Most handicapped students, including learning disabled, mentally retarded, hearing impaired, emotionally disturbed, and language disordered, achieve at higher levels with CAL than with conventional instruction alone.
- There are no significant differences in the effectiveness of CAL as far as gender of learners is concerned.
- Students' fondness for CAL activities centres on the immediate, objective, and positive feedback provided by these activities.
- CAL activities appear to be at least as cost-effective as — and sometimes more cost-effective than— other instructional methods, such as teacher-directed instruction and tutoring.

Most programmes of computer-based instruction evaluated in the past have produced positive effects on student learning and attitudes. Further programmes for developing and implementing computer-based instruction should therefore be encouraged.

FORMAL CHARGE – A NOVEL METHOD FOR TEACHING THEORETICAL INORGANIC CHEMISTRY

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All atoms within a neutral molecule need not be neutral. The location of any charge is often important for understanding reactivity of the molecule. Ions bear a positive or negative charge. If the ion is polyatomic (i.e. constructed of more than one atom), we might ask which atom (s) of ion carry the charge? Thus knowledge of charge distribution over the atoms in a molecule or ion (identification of atom that are electron rich or electron poor) can be useful to interpret many facets of organic chemistry, including how and why reactions occur (mechanisms) or how molecules interact with each other, a feature which strongly influences physical and biological properties.

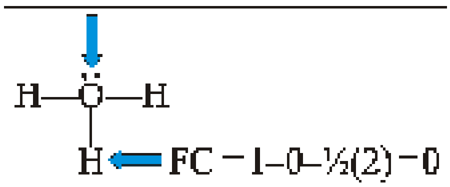
Chemists have developed a very simple book keeping method to determine if an atom within a molecule or ion is neutral, or bears a positive or negative charge. The method provides integer charge only. Because this method provides some indication of charge distribution, it is an excellent starting point for determining electron distribution within a molecule or an ion, hence gives a starting point to predict chemical and physical properties. These assigned integer charges are called formal charges. A formal charge is a comparison of electrons owned by an atom in a Lewis structure versus the number of electrons possessed by the same atom in its unbound, free atomic state. Also formal charge is way of counting electrons involved in bonding.

Formal charge is calculated as follows :

FC = GN – UE – 1/2BE
FC = formal charge
GN = periodic table group number (number of valence electrons in free, nonbonded atom)
UE = number of unshared electrons
BE = number of electrons shared in covalent bonds.
OR FC = (number of valence electrons in the neutral atom) – (number of electrons in lone pair) – (number of covalent bonds)

Thus for hydronium ion, (H_3O^+)

FC = 6 – 2 – ½(6) = +1



The formal charge on hydrogen is calculated as follows. Hydrogen has one valence electron (GN=1), no unshared (UE = 0) and two shared electrons in the oxygen - hydrogen covalent bond (BE = 2). Thus the calculated formal charge on hydrogen is zero.

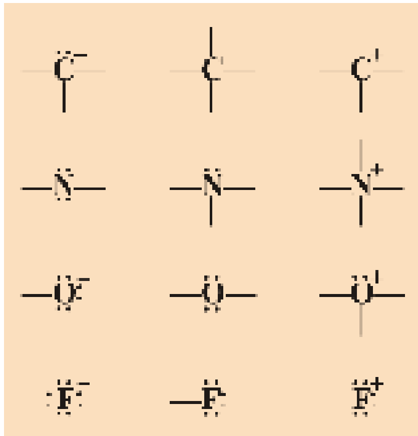
Because, each hydrogen atom in this molecule is identical, each hydrogen atom has the same formal charge of zero. Any hydrogen bearing one covalent bond always has a formal charge of zero.

Similarly, the formal chargeon oxygen is calculated as follows. Oxygen has six valence electrons (GN = 6), two unshared in one lone pair (UE = 2), a six shared electrons in three oxygen- hydrogen covalent bonds (BE =6). Thus, the calculated formal charge on oxygen is +1. This indicates the oxygen atom bears the majority of the positive charge of this ion.

In addition to above methods, it is also possible to determine formal charge instinctively based on comparing structure. The instinctive method is based on comparing the structure with common, known neutral structures. To do this it needs to recognise the common neutral structures: that means 'C' has 4 bonds; N has 3 bonds with one lone pair, O has 2 bonds with two lone pair, F has one bond with three lone pairs. For more clarity refer Table No.1.

- In the middle of the Table 1 are the neutral bonding situation for C, N, O and halogen F (Just think of each central atom bond being to a hydrogen).
- To the left, a bond has been lost but converted to a lone pair, so the central atom has gained an electron and become (-ve).
- To the right, there are two scenarios : (i) C and F has lost the shared electron of a bond, so losing one electron from the count to become positive (+ve) (ii) N and O have converted two unshared electrons into a shared pair of electrons in a bond, so losing one electron from the count to become positive (+ve).

Table-1



Thus, to find formal charge we follow the following steps:

(1) We count the valence electrons that belong to each atom. For this it should be remembered that

- Unshared pairs belong entirely to the atom on which they reside.
- Shared pairs of electrons are equally between the atoms by which they are shared: Half belong to one atom, and half belong to the other.

(2) Compare the number of electrons that belong to each atom in a molecule or ion with the number of valence electrons brought into bonding by the neutral atom. That means carbon always bring 4 valence electrons into bonding, nitrogen brings five electrons into bonding, oxygen brings 6 electrons into bonding, halogens brings 7 electrons into bonding and hydrogen brings 1 electrons into bonding.

(3) If the number of valence electrons belonging to the atom in a molecule or ion is different from the number that belong to the neutral atom, the atom has a formal charge. That means if the number of electrons that belong is one more than the number in neutral atom, then the formal charge wouldbe –1. If the number of electrons that belong to on atom in a molecule or ion is one less than the number of electrons on neutral atom, the formal charge is +1. If the number of electrons that belong is same as the number brought into bonding, the formal charge is 0.

Selection of Reasonance Structures

Basing on formal charge it is possible to select the appropriate resonance structure of any molecule out of several possible Lewis structures. Few tips to determine appropriate Lewis structure as follows :

(1) The best Lewis structure for resonance contributing structure has the least number of atoms with formal charge.

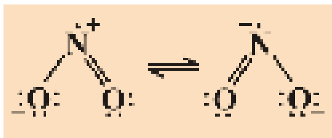
(2) Equivalent atoms have the same formal charge. For example, all the hydrogen atoms of methane (CH_4) are equivalent and therefore have the same formal charge. All six hydrogen atoms in ethane (H_3C-CH_3) have the same formal charge, as do the two carbon atoms.

(3) Formal charges other than +1, 0 or –1 are uncommon except for metals.

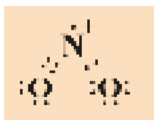
(4) If the sum of the formal charge is 0, the species is a molecule and if the sum of the formal charge is not 0, then the species is an ion.

Resonance and Formal charge

Resonance structure often have formal charges associated with them. For instance NO_2 molecules formal charge can be calculated as:



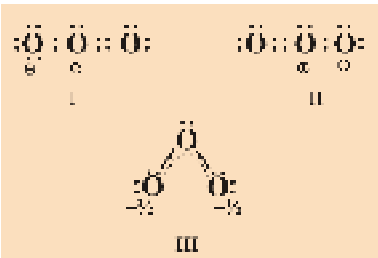
In structure II the right hand oxygen has three nonbonding pairs, so this counts for six electrons. Then oxygen gets one of the two electrons in the bond with nitrogen. That's the number of electrons 7, giving the O a minus one formal charge.



The other O has two nonbonding pairs of electrons and it also gets its share of 2 of four electrons present in the double bond. That's six electrons, thus the left hand O has no formal charge.

The nitrogen gets its share of two electrons from the double bond, one from the single bond and one from the half-filled orbital associated with it. That's a total of electrons. This gives 'N' a +1 formal charge since it needs 5 electrons to be neutral.

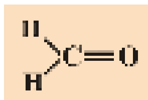
Similarly, consider the important allotrope of oxygen, ozone. This molecule is known to be bent but not an equilateral triangle. It is also known that it is symmetric with respect to the O-O bonds. (It does infact have a two-fold symmetry axis, and two perpendicular symmetry planes i.e. C_{2v} symmetry) The Lewis theory cannot predict this structure without assigning formal charges to resonance structures. Ozone can be represented as:



In structure III, the two terminal oxygen possesses ½ charges whereas the middle oxygen possesses one positive charge. It is however to be noted that for all resonating structures we can't write formal charges. For instance benzene and its homologue because of their aromatic stabilisation and delocalised pi (π) electronic cloud.

To sum up, formal charge is an important tool in solving conceptual problems in chemistry i.e. stability, structure elucidation, reactivity, acidity, etc. of molecules or ions. Also, it offers reasonable explanation to the following :

1. N_2 is stable but isoelectronic CO is reactive.
2. HPO_3 readily combines with water to form H_3PO_4 while HNO_3 has no such tendency.
3. Acidic strength decreases in the order $HClO_4 > HClO_3 > HClO_2 > HClO$.
4. HNO_3 is a stronger acid than HNO_2.
5. Ozone is less stable than O_2.
6. SO_3, PO_3 polymerise (linear chains), silicates polymerise sharing corner, while NO_3^- can't.
7. The plausible structure of formaldehyde is HCHO, i.e.



8. J. Ricci explained the acidic character of oxy acids in terms of formal charge as :

   pK = 5.0-m (9.0) + n(4.0)

   where m = formal charge on central atom,

   n = number of non hydroxyl oxygen atoms in the acids.

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ALTERNATIVE FUELS – A BOON FOR FUTURE GENERATIONS

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"The stocks of petroleum, coal, propane, and natural gas will be consumed in a few years."
"Most of the observed increase in globally averaged temperatures since the mid-20th century is due to the observed increase in anthropogenic greenhouse gas concentrations."
"The majority of the known petroleum reserves are located in the Middle East and thus worldwide fuel shortages would intensify the unrest that exists in the region, leading to further conflict and war."

This concern and words of apprehension regarding conventional petroleum products has been starting the people all over the world since a decade. There is a growing anxiety due to general environmental, economic, and geopolitical matters of sustainability of the petroleum products. Also the prices of the fossils fuels have been upsurging day-by-day. The only solution to these problems is the identification and usage of the alternative fuels in industry, transportation and in economy of the world.

What are Alternative Fuels?

Alternative fuels are also known as non-conventional fuels and are substances that can be used as fuels, other than conventional fuels. Conventional fuels include : fossil fuels (petroleum (oil), coal, propane, and natural gas), and nuclear materials such as uranium. An array of alternative fuels are there viz. biodiesel, bioalcohol (methanol, ethanol, butanol), chemically stored electricity (batteries and fuel cells), hydrogen, non-fossil methane, non-fossil natural gas, vegetable oil and other biomass sources.

Why is there an increasing demand for alternative fuels?

A variety of reasons contribute towards the increased demand for alternative fuels,

1. Environmental Concern - The major environmental concern, according to an IPCC report, is that "Most of the observed increase in globally averaged temperatures since the mid-20th century is due to the observed increase in anthropogenic greenhouse gas concentrations." Since burning fossil fuels is known to increase greenhouse gas concentrations in the atmosphere, they are a likely contributor to global warming.

2. Economic and Political Concern - The majority of the known petroleum reserves are located in the Middle East. There is general concern that worldwide fuel shortage could intensify the unrest that exists in the region, leading to further conflict and war.

3. Limited Reserves of the Alternative fuels - Other important concern which have fuelled demand revolve around the concept of peak oil, which predicts rising fuel costs as production rates of petroleum enter a terminal decline. According to the Hubbert peak theory, when the production levels peak, demand for oil will exceed supply and without proper mitigation this gap will continue to grow as production drops, which could cause a major energy crisis.

Biodiesel

Biodiesel refers to a vegetable oil - or animal fat-based diesel fuel consisting of long-chain alkyl (methyl, propyl or ethyl) esters. Biodiesel is typically made by chemically reacting lipids (e.g., vegetable oil, animal fat (tallow) with an alcohol. Biodiesel is meant to be used in standard diesel engines alone, or blended with petrodiesel.

Biodiesel can be produced from a great variety of feedstocks like vegetable oils (soyabean, cottonseed, peanut, sunflower, coconut, etc.) and animal fats (tallow) as well as waste oils (used frying oils).

The problem with the use of biodiesel includes the inherent higher price of the biodiesel, which in many countries is offset by legislative and regulatory incentives or subsidies in the form of reduced excise taxes, Slightly increased NOX exhaust emissions from biodiesel burning, oxidative stability, and Cold flow properties which are especially relevant in cold countries.

Bioalcohol (Methanol and ethanol)

Ethanol is generally made from corn, biomass (agricultural crops and waste like rice straw), plant material left from logging, and trash including cellulose. Methanol can be made from various biomass resources like wood, as well as from coal. However, today nearly all methanol is made from natural gas, because it is cheaper.

Methanol and ethanol are not primary sources of energy; however, they are convenient fuels for storing and transporting energy. These alcohol can be used in internal combustion engines such as flexible fuel vehicles with minor modifications.

The use of bioethanol in replacing fossil fuels in vehicles is a matter of concern as large amount of arable land is required for crops resulting in imbalance of environment and energy but recent developments with cellulosic ethanol production and commercialisation may assuage these concerns.

Chemically stored electricity

Chemically stored electricity is used to run electric cars, T.V. and electrical appliances etc. Electric vehicles receive their power from various sources, including fossil fuels, nuclear power, and renewable sources (tidal power, solar power, and wind power) or any combination of those. After generation, this energy is then transmitted to the vehicle through use of overhead lines, wireless energy transfer, or a direct connection through an electrical cable. The electricity may then be stored onboard the vehicle using a battery, flywheel, super capacitor, or fuel cell. A key advantage of electric or hybrid electric vehicles is their ability to recover braking energy as electricity to be restored to the on-board battery or sent back to the grid whereas when fossil fuel vehicles brake, they simply dump the energy into the environment as waste heat.

The problem with electric vehicles is of long recharge times compared to the relatively fast process of refuelling a tank which is further complicated by the current scarcity of public charging stations.

Hydrogen

Hydrogen is the lightest of all elements, easy to produce through electrolysis, burns nearly pollution-free and being a non-carbon fuel, the exhaust is free of carbon dioxide.

Hydrogen as a fuel can be an asset but there is no accessible natural reserve of uncombined hydrogen, since what little there is resides in Earth's outer atmosphere. Therefore, hydrogen for use as fuel must first be produced using another energy source, making it a means to transport energy, rather than an energy source.

One existing method of hydrogen production is steam methane reformation; however, this method requires methane, which raises sustainability concerns. Another method of hydrogen production is through electrolysis of water, in which electricity generated from any source can be used. Photoelectrolysis, biohydrogen, and biomass or coal gasification have also been proposed as means to produce hydrogen. Hydrogen has thus currently become impractical to be used as an alternative fuel.

Alternative fossil fuels

Compressed natural gas (CNG) is a common fuel which comes from underground. However, natural gas is a gas like air, rather a liquid like petroleum. It has been found to be one of the most environmentally friendly fuels and is used to power a car or truck. Natural gas is made up of methane (95 per cent) and the other 5 per cent is made up of various gases like butane, propane, ethane along with small amounts of water vapour. However, natural gas is a finite resource like all fossil fuels, and its production is expected to peak soon after oil does.

Liquefied natural gas (LNG) is made by refrigerating natural gas to –260° F to condense it into a liquid (liquefaction) which removes most of the water vapour, butane, propane, and other trace gases, that are usually included in ordinary natural gas. The resulting LNG is usually more than 98 per cent pure methane. The liquid form is much denser than natural gas or CNG and has much more energy. LNG is good for large trucks that need to go a long distance before they stop for more fuel.

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SCIENCE NEWS

Nanotechnology Used In Biofuel Process

Dr James Palmer, Associate Professor of chemical engineering at Louisiana Tech University, in collaboration with fellow professors Dr Yuri Lvov, Dr Dale Snow, and Dr Hisham Hegab, has developed the technology that would capitalise the environmental and financial benefits of "biofuels" by using nanotechnology to further improve the cellulosic ethanol processes.

Biofuels are expected to play an important role in search for sustainable fuels and energy production solutions for the future. The demand for fuel in future, however, cannot be satisfied with traditional crops such as sugarcane or corn alone. Emerging technologies are allowing cellulosic biomass (wood, grass, stalks, etc.) to be also converted into ethanol. Cellulosic ethanol does not compete with food production and has the potential to decrease emissions of greenhouse gases (GHG) by 86 per cent over that of today's fossil fuels. Current techniques for corn ethanol reduce greenhouse gases by only 19 per cent.

The nanotechnology processes developed at Louisiana Tech University, allows immobilisation of expensive enzymes used to convert cellulose to sugars, and thus makes them available for reuse several times over thereby significantly reducing the overall cost of the process. Savings estimates range from approximately $32 million for each cellulosic ethanol plant. This process can easily be applied in large scale commercial environments and can immobilise in a wide variety or mixture of enzymes production.

(Source: Science Daily online)

Giant Leap for Nerve Cell Repair

The repair of damaged nerve cells is a major problem in medicine today. A new study by Dr David Colman, Director at the Montreal Neurological Institute and Hospital (The Neuro) and his research team, is a significant advance towards a solution for neuronal repair. The study featured first to show that nerve cells will grow and make meaningful, functional contacts, or synapses, the specialised junctions through which neurons signal to each other with an artificial component, in this case, plastic beads coated with a substance that encourages adhesion, and attracts the nerve cells.

Many therapies, most still in the conceptual stage, are aiming at to restore the connection between the nerve cell and the severed nerve Fibres that innervate a target tissue, typically muscle. Traditional approaches to therapies would require the re-growth of a severed nerve fibre by a distance of up to one metre in order to potentially restore function. The new approach, according to researchers, bypasses the need to force nerve cells to artificially grow these long distances, and eliminates the demand for two neurons to make a synapse, both of which are considerable obstacles to neuronal repair in a damaged system.

The synapses generated in this research are virtually identical to their natural counterparts except the 'receiving' side of the synapse is an artificial plastic rather than another nerve cell or the target tissue itself. This study is the first that uses these particular devices, to show that adhesion is a fundamental first step in triggering synaptic assembly.

In order to assess function that is transmission of a signal from the synapse they stimulated the nerve cells with electricity, sending the signal, an action potential, to the synapse. By artificially stimulating nerve cells in the presence of dyes, they could see that transmission had taken place as the dyes were taken up by the synapses.

They believe that within the next five years, it will be possible to have a fully functional device that will be able to directly convey natural nerve cell signals from the nerve cell itself to an artificial matrix containing a mini-computer that will communicate wirelessly with target tissues. These results not only provide a model to understand how neurons are formed which can be employed in subsequent studies but also provides hope for those affected and potentially holds promise for the use of artificial substrates in the repair of damaged nerves.

(Source: Science Daily online)

New Mesozoic Mammal

Dr Zhe-Xi Luo, curator of vertebrate paleontology and associate director of science and research at Carnegie Museum of Natural History and his colleagues have discovered a new species of mammal that lived 123 million years ago in Liaoning Province in northeastern China. The newly discovered animal, *Maotherium asiaticus*, comes from famous fossil-rich beds of the Yixian Formation.

Maotherium asiaticus is a symmetrodont, meaning that it has teeth with symmetrically arranged cusps specialised for feeding on insects and worms. It lived on the ground and had a body 15 cm long and weighing approximately 70 to 80 g. By studying all features in this exquisitely preserved fossil, researchers believe *Maotherium* to be more closely related to marsupials and placentals than to monotremes primitive egg laying mammals of Australia and New Guinea such as the platypus.

This new remarkably well preserved fossil, offers an important insight into how the mammalian middle ear evolved. The discoveries of such exquisite dinosaur age mammals from China provide developmental biologists and paleontologists with evidence of how developmental mechanisms have impacted the morphological evolution of the earliest mammals and sheds light on how complex structures can arise in evolution because of changes in developmental pathways.

Mammals have highly sensitive hearing, far better than the hearing capacity of all other vertebrates, and hearing is fundamental to the mammalian way of life. The mammalian ear evolution is important for understanding the origins of key mammalian adaptations. The intricate middle ear structure of mammals (including humans) has more sensitive hearing, discerning a wider range of sounds than other vertebrates. This sensitive hearing was a crucial adaptation, allowing mammals to be active in the darkness of the night and to survive in the dinosaur dominated Mesozoic.

Mammalian hearing adaptation is made possible by a sophisticated middle ear of three tiny bones, known as the hammer (malleus), the anvil (incus), and the stirrup (stapes), plus a bony ring for the eardrum (tympanic membrane). These mammal middle ear bones evolved from the bones of the jaw hinge in their reptilian relatives. Paleontologists have long attempted to understand the evolutionary pathway via which these precursor jawbones became separated from the jaw and moved into the middle ear of modern mammals.

According to the Chinese and American scientists who studied this new mammal, the middle ear bones of *Maotherium* are partly similar to those of modern mammals; but *Maotherium*'s middle ear has an unusual connection to the lower jaw that is unlike that of adult modern mammals. This middle ear connection, also known as the ossified Meckel's cartilage, resembles the embryonic condition of living mammals and the primitive middle ear of pre-mammalian ancestors. Because *Maotherium asiaticus* is preserved three-dimensionally, paleontologists were able to reconstruct how the middle ear attached to the jaw. This can be a new evolutionary feature, and can be interpreted as having a "secondarily reversal to the ancestral condition," meaning that the adaptation is caused by changes in development.

Modern developmental biology has shown that developmental genes and their gene network can trigger the development of unusual middle ear structures, such as "re-appearance" of the Meckel's cartilage in modern mice. The middle ear morphology in fossil mammal *Maotherium* of the Cretaceous (145-65 million years ago) is very similar to the mutant morphology in the middle ear of the mice with mutant genes. The scientific team studying the fossil suggests that the unusual middle ear structure, such as the ossified Meckel's cartilage, is actually the manifestation of developmental gene mutations in the deep times of Mesozoic mammal evolution.

(Source: Science Daily online)

Smaller and More Efficient Nuclear Battery

Batteries can power anything from small sensors to large systems. While scientists are finding ways to make them smaller but even more powerful, problems can arise when these batteries are much larger and heavier than the devices themselves. Jae Kwon, Assistant Professor of electrical and computer engineering at University of Missouri and his research team, are developing a nuclear energy source that is smaller, lighter and more efficient. To provide enough power, it will need certain methods with high energy density. The radioisotope battery can provide power density that is six orders of magnitude higher than chemical batteries.

Dr Kwon and his research team have been working on building a small nuclear battery, currently the size and thickness of a penny, intended to power various micro/nanoelectromechanical systems (M/NEMS). Although nuclear batteries can pose concerns, they are safe. However, nuclear power sources have already been safely powering a variety of devices, such as pace-makers, space satellites and underwater systems. His innovation is not only in the battery's size, but also in its semiconductor. Kwon's battery uses a liquid semiconductor rather than a solid semiconductor. The critical part of using a radioactive battery is that when energy is drawn from it, part of the radiation energy can damage the lattice structure of the solid semiconductor. By using a liquid semiconductor, this problem will minimise.

In the future, they hope to increase the battery's power, shrink its size and try with various other materials. According to Kwon, the battery could be thinner than the thickness of human hair.

(Source: Science Daily online)

ALICE: New Aluminium-water Rocket Propellant

Steven Son, associate professor of mechanical engineering at Purdue University and his Research team have developed a new type of rocket propellant made from a frozen mixture of water and "nanoscale aluminium" powder that is more environmentally friendly than conventional propellants and could be manufactured on the Moon, Mars and other water-bearing bodies.

The aluminium-ice, or ALICE, propellant might be used to launch rockets into orbit and for long-distance space missions and also to generate hydrogen for fuel cells. ALICE developed on the Air Force Office of Scientific Research and Pennsylvania State University, was used earlier to launch a 9-foot-tall (2.75 m) rocket. The vehicle reached an altitude of 1,300 feet (396 m). The tiny size of the aluminium particles, which have a diametre of about 80 nanomets, or billionths of a metre, is a key to the propellant's performance. The nanoparticles combust more rapidly than larger particles and enable better control over the reaction and the rocket's thrust.

ALICE provides thrust through a chemical reaction between water and aluminium. As the aluminium ignites, water molecules provide oxygen and hydrogen to fuel the combustion until all of the powder is burned. ALICE might one day replace some liquid or solid propellants, and, when perfected, might have a higher performance than conventional propellants. It is also extremely safe while frozen because it is difficult to get it ignited accidentally. It could be improved and turned into a practical propellant. Theoretically, it also could be manufactured in distant places like the Moon or Mars instead of being transported at high cost. Findings from spacecraft indicate the presence of water on Mars and the Moon, and water also may exist on asteroids, other moons and bodies in space.

Manufacturers over the past decade have learned, how to make higher quality nano aluminium particles than was possible in the past. The fuel needs to be frozen for two reasons: it must be solid to remain intact while subjected to the forces of the launch and also to ensure that it does not slowly react before it is used. Initially a paste, the fuel is packed into a cylindrical mold with a metal rod running through the centre. After it is frozen, the rod is removed, leaving a cavity running the length of the solid fuel cylinder. A small rocket engine above the fuel is ignited, sending hot gasses into the central hole, causing the ALICE fuel to ignite uniformly.

Other researchers previously have used aluminium particles in propellants, but those propellants usually also contained larger, micron-size particles, whereas the new fuel contained pure nanoparticles. Future work will focus on perfecting the fuel and also may explore the possibility of creating a gelled fuel using the nanoparticles. Such a gel would behave like a liquid fuel, making it possible to vary the rate at which the fuel is pumped into the combustion chamber to throttle the motor up and down and increase the vehicle's distance. A gelled fuel also could be mixed with materials containing larger amounts of hydrogen and then used to run hydrogen fuel cells in addition to rocket motors.

The research is helping to train a new generation of engineers to work in academia, industry, for NASA and the military. It is unusual for students to get this kind of advanced and thorough training to go from a basic-science concept all the way to a flying vehicle that is ground tested and launched. This is the whole spectrum.

(Source: Science Daily online)

Does Moon have Water!

According to Dr Vincent Eke, in the Institute for Computational Cosmology, at Durham University, Crashing a rocket into the Moon will create "one more dimple" on the lunar surface and could find water ice on Earth's nearest neighbour.

The Lunar Crater Observation and Sensing Satellite (LCROSS) and its Centaur rocket was made to smash into a crater in the Cabeus region of the Moon's South Pole in the second week of October 2009. This site has been chosen in view of higher concentration of hydrogen found in the region which could be due to the hydrogen in water present there as water ice. The rocket has roughly the mass of a Transit van and it will hit the Moon at about 5,600 miles per hour (9 000 km/h). The energy of the collision has been estimated to be roughly equivalent to two tonnes of TNT. It has been estimated that the impact would hurl approximately 350 tonnes of material up from moon's surface and will be propelled into the sunlight so that scientists can study its composition by using ground-based telescopes.

It may be recalled that in September 2009, India's Chandrayaan-1 probe had found that particles that make up the Moon's soil are coated with small amounts of H_2O. It is contemplated that this water in the form of ice could be found in the frozen confines of the Moon's polar craters where temperatures are in the vicinity of minus 170 degrees Celsius. If it is so, then the Chandrayaan-1 data would imply that the top metre of the surface in these craters holds about 200,000 million litre of water.

According to Dr Eke, water ice could be stable for billions of years on the Moon provided that it is cold enough. If ice is present in the permanently shaded lunar craters of the Moon then it could potentially provide a water source for the eventual establishment of a manned base on the Moon. Such a base could be used as a platform for exploration into the further reaches of our solar system.

(Source: Science Daily online)

Nobel Prize in Physics: Creators of Optical Fibre Communication and CCD Image Sensor

The Royal Swedish Academy of Sciences has decided to award the Nobel Prize in Physics for 2009 with one half to Charles K. Kao, Standard Telecommunication Laboratories, Harlow, UK, and Chinese University of Hong Kong "for groundbreaking achievements concerning the transmission of light in fibres for optical communication, and the other half jointly to Willard S. Boyle and George E. Smith, Bell Laboratories, Murray Hill, NJ, USA "for the invention of an imaging semiconductor circuit CCD sensor".

This year's Nobel Prize in Physics is awarded for two scientific achievements that have helped to shape the foundations of today's networked societies. They have created many practical innovations for everyday life and provided new tools for scientific exploration.

In 1966, Charles K. Kao made a discovery that led to a breakthrough in fibre optics. He carefully calculated how to transmit light over long distances via optical glass fibres. With a fibre of purest glass it would be possible to transmit light signals over 100 kilometres, compared to only 20 metres for the fibres available in the 1960s. Kao's enthusiasm inspired other researchers to share his vision of the future potential of fibre optics. The first ultrapure fibre was successfully fabricated just four years later, in 1970.

Today optical fibres make up the circulatory system that nourishes our communication society. These low-loss glass fibres facilitate global broadband communication such as the Internet. Light flows in thin threads of glass, and it carries almost all of the telephony and data traffic in each and every direction. Text, music, images and video can be transferred around the globe in a split second.

If we were to unravel all of the glass fibres that wind around the globe, we would get a single thread over one billion kilometres long – which is enough to encircle the globe more than 25 000 times – and is increasing by thousands of kilometres every hour.

A large share of the traffic is made up of digital images, which constitute the second part of the award. In 1969 Willard S. Boyle and George E. Smith invented the first successful imaging technology using a digital sensor, a CCD (Charge-Coupled Device). The CCD technology makes use of the photoelectric effect, as theorised by Albert

Einstein and for which he was awarded the 1921 year's Nobel Prize. By this effect, light is transformed into electric signals. The challenge when designing an image sensor was to gather and read out the signals in a large number of image points, pixels, in a short time.

The CCD is the digital camera's electronic eye. It revolutionised photography, as light could now be captured electronically instead of on film. The digital form facilitates the processing and distribution of these images. CCD technology is also used in many medical applications, e.g. imaging the inside of the human body, both for diagnostics and for microsurgery.

Digital photography has become an irreplaceable tool in many fields of research. The CCD has provided new possibilities to visualise the previously unseen. It has given us crystal clear images of distant places in our universe as well as the depths of the oceans.

(Source: Science Daily online)

Physicist Makes New High-resolution Panorama of Milky Way

Cobbling together 3000 individual photographs, a physicist Axel Mellinger, a professor at Central Michigan University, has made a new high-resolution panoramic image of the full night sky, with the Milky Way galaxy as its centrepiece.

This panorama image shows stars 1000 times fainter than the human eye can see, as well as hundreds of galaxies, star clusters and nebulae. Its high resolution makes the panorama useful for both educational and scientific purposes.

Mellinger spent 22 months and travelled over 26,000 miles (41, 800 km) to take digital photographs at dark sky locations in South Africa, Texas and Michigan. Each photograph is a two-dimensional projection of the celestial sphere. As such, each one contains distortions, in much the same way that flat maps of the round Earth are distorted. In order for the images to fit together seamlessly, those distortions had to be accounted for that Mellinger used a mathematical model and hundreds of hours in front of a computer.

Due to artificial light pollution, natural air glow, as well as sunlight scattered by dust in our solar system, it is virtually impossible to take a wide-field astronomical photograph that has a perfectly uniform background. To fix this, he used data from the Pioneer 10 and 11 space probes. The data allowed him to distinguish star light from unwanted background light. He could then edit out the varying background light in each photograph. That way they would fit together without looking patchy.

The result is an image of our home galaxy that no star-gazer could ever see from a single spot on earth. Mellinger plans to make the giant 648 megapixel image available to planetariums around the world.

(Source: Science Daily online)

New Evidence on Formation of Oil and Gas

Scientists in Washington, D.C. are reporting laboratory evidence supporting the possibility that some of Earth's oil and natural gas may have formed in a way much different than the traditional process.

According to Anurag Sharma and colleagues the traditional process involves biological process i.e. prehistoric plants died and changed into oil and gas while sandwiched between layers of rock in the hot, high-pressure environment deep below Earth's surface. Some scientists, however, believe that oil and gas originated in other ways, including chemical reactions between carbon dioxide and hydrogen below the Earth's surface.

The genesis of the new study lies on the description of the process suggested by famous Russian chemist Dimitri Mendeleev some time around 1877. Taking their clue from this the researchers combined ingredients for this so-called abiotic synthesis of methane, the main ingredient in natural gas, in a diamond-anvil cell and monitored *in-situ* the progress of the reaction. The diamond anvils can generate high pressures and temperatures similar to those that occur deep below Earth's surface and allow for *in-situ* optical spectroscopy at the extreme environments.

The results strongly suggest that some methane could form strictly from chemical reactions in a variety of chemical environments. This study further highlights the role of reaction pathways and fluid immiscibility in the extent of hydrocarbon formation at extreme conditions simulating deep subsurface.

(Source: Science Daily online)

Mathematical Model to Explain How the Brain Might Stay in Balance

The human brain is made up of 100 billion of neurons, acting like live wires, which must be kept in delicate balance to stabilise the world's most magnificent computing organ. Too much excitement and the network will slip into an apoplectic, uncomprehending chaos. Too much inhibition and it will flat line. Marcelo O. Magnasco, Head of the Laboratory of Mathematical Physics at The Rockefeller University, and his colleagues have developed a new mathematical model that describes how the trillions of interconnections among neurons could maintain a stable but dynamic relationship that leaves the brain sensitive enough to respond to stimulation without veering into a blind seizure.

How such a massively complex and responsive network, such as the brain, can balance the opposing forces of excitation and inhibition? According to Magnasco, neurons function together in localised groups to preserve stability. The defining characteristic of system is that the unit of behaviour is not the individual neuron or a local neural circuit but rather groups of neurons that can oscillate in synchrony. The result is that the system is much more tolerant to faults, individual neurons may or may not fire, individual connections may or may not transmit information to the next neuron, but the system keeps functioning.

Magnasco's model differs from traditional models of neural networks, which assume that each time a neuron fires and stimulates an adjoining neuron, the strength of the connection between the two increases. This is called the Hebbian theory of synaptic plasticity and is the classical model for learning. But the Magnasco system is anti-Hebbian. If the connections among any groups of neurons are strongly oscillating together, they are weakened because they threaten homeostasis. Instead of trying to learn, our neurons are trying to forget. One advantage of this anti-Hebbian model is that it balances a network with a much larger number of degrees of freedom than classical models can accommodate, a flexibility that is likely required by a computer as complex as the brain.

Magnasco theorises that the connections that balance excitation and inhibition are continually flirting with instability. He compares the behaviour of neurons to a network of indefinitely large number of public address systems tweaked to that critical point at which a flick of the microphone brings on a screech of feedback that then fades to quiet with time.

This model of a balanced neural network is abstract; it does not try to recreate any specific neural function such as learning. But it requires only half of the network connections to establish the homeostatic balance of exhibition and inhibition crucial to all other brain activity. The other half of the network could be used for other functions that may be compatible with more traditional models of neural networks, including Hebbian learning.

Developing a systematic theory of how neurons communicate could provide a key to some of the basic questions that researchers are exploring through experiments. This model could be one part of a better understanding. It has a large number of interesting properties that make it a suitable substrate for a large-scale computing device.

(Source: Science Daily online)

Genomes of Biofuel Yeasts Mapped

As global temperatures and energy costs continue to soar, renewable sources of energy will be key to a sustainable future. An attractive replacement for gasoline is biofuel, and in two studies scientists have analysed the genome structures of bioethanol producing microorganisms, uncovering genetic clues that will be critical in developing new technologies needed to implement production on a global scale.

Bioethanol is produced from the fermentation of plant material, such as sugar cane and corn, by the yeast *Saccharomyces cerevisiae*, just as in the production of alcoholic beverages. However, yeast strains thriving in the harsh conditions of industrial fuel ethanol production are much harder than their beer brewing counterparts, and surprisingly little is known about how this yeast adapted to the industrial environment. If researchers can identify the genetic changes that underlie this adaptation, new yeast strains could be engineered to help shift bioethanol production into high gear across the globe.

Two studies have taken a major step toward this goal, identifying genomic properties of industrial fuel yeasts that likely gave rise to more robust strains. In one of the studies, researcher Lucas Argueso and colleagues from Duke University at USA and Brazil have sequenced and analysed the structure of the entire genome of strain PE-2, a prominent industrial strain in Brazil. Their work revealed that portions of the genome are plastic compared to other yeast strains, specifically the peripheral regions of chromosomes, where they observed a number of sequence rearrangements.

Interestingly, these chromosomal rearrangements in PE-2 amplified genes involved in stress tolerance, which likely contributed to the adaptation of this strain to the industrial environment. As PE-2 is amenable to genetic engineering, the authors believe that their work on PE-2 will open the door to development of new technologies to boost bioethanol production.

In a second study conducted by Boris Stambuk from Stanford University, USA and Gavin Sherlock Brazil, the two scientists have also analysed the genome structure of industrial bioethanol yeasts, searching for variations in the number of gene copies in five strains employed in Brazil, including PE-2. Stambuk and colleagues found that all five industrial strains studied harbour amplifications of genes involved in the synthesis of vitamins B6 and B1 compounds critical for efficient growth and utilisation of sugar.

The group experimentally demonstrated that the gene amplifications confer robust growth in industrial conditions, indicating that these yeasts are likely adapted to limited availability of vitamins in the industrial process to gain a competitive advantage. Furthermore, the researchers suggest that this knowledge can be utilised to engineer new strains of yeast capable of even more efficient bioethanol production, from a wider range of agricultural stocks.

It is evident that an expanding human population will require more energy that exerts less impact on the environment, and the information gained from these genomic studies of industrial bioethanol yeasts will be invaluable as biofuel researchers optimise production and implement the technology worldwide.

(Source: Science Daily online)

'Ultra-primitive' Particles Found In Comet Dust

Interplanetary dust particles with presolar grains: Scanning electron images of two dust particles E1 (panel A) and G4 (B) and secondary ion mass spectrometry isotopic ratio maps (C—D). Oxygen isotope maps of particles E1 (C) and G4 (D) show four and seven isotopically anomalous regions, indicated by circles, which have been identified as presolar grains. The scale bars are 2 microns.

According to Larry Nittler and his colleagues, Department of Terrestrial Magnetism at Carnegie Institution, dust samples collected by high-flying aircraft in the upper atmosphere have yielded an unexpectedly rich trove of relics from the ancient cosmos. The stratospheric dust includes minute grains that had formed inside stars that lived and died long before the birth of our sun, as well as material from molecular clouds in interstellar space. This ultra-primitive material likely wafted into the atmosphere after the Earth passed through the trail of an Earth crossing comet in 2003.

At high altitudes, most dust in the atmosphere comes from space, rather than the Earth's surface. Thousands of tons of interplanetary dust particles (IDPs) enter the atmosphere each year. The only known cometary samples are those that were returned from comet 81P/Wild 2 by the Stardust mission. The Stardust mission used a NASA-launched spacecraft to collect samples of comet dust, returning to Earth in 2006.

Comets are thought to be repositories of primitive, unaltered matter left over from the formation of the solar system. Material held for eons in cometary ice has largely escaped the heating and chemical processing that has affected other bodies, such as the planets. However, the Wild 2 dust returned by the Stardust mission included more altered material than expected, indicating that not all cometary material is highly primitive.

The IDPs used in the current study were collected by NASA aircraft after the Earth passed through the dust trail of comet Grigg-Skjellerup. The research team comprising Nittler, Henner Busemann, Ann Nguyen, George Cody, analysed a sub-sample of the dust to determine the chemical, isotopic and micro-structural composition of its grains. They are very different from typical IDPs. They are more primitive, with higher abundances of material whose origin predates the formation of the solar system. The distinctiveness of particles plus the timing of their collection after the Earth's passing through the comet trail, point to their source being the Grigg-Skjellerup comet.

This is exciting because it allows us to compare on a microscopic scale in the laboratory dust particles from different comets. We can use them as tracers for different processes that occurred in the solar system four-and-a-half billion years ago.

The biggest surprise for the researchers was the abundance of so-called pre-solar grains in the dust sample. Pre-solar grains are tiny dust particles that formed in previous generations of stars and in supernova explosions before the formation of the solar system. Afterwards, they were trapped in our solar system as it was forming and are found today in meteorites and in IDPs. Pre-solar grains are identified by having extremely unusual isotopic compositions compared to anything else in the solar system.

But pre-solar grains are generally extremely rare, with abundances of just a few parts per million in even the most primitive meteorites, and a few hundred parts per million in IDPs. In the IDPs associated with comet Grigg-Skjellerup they are up to the per cent level. This is tens of times higher in abundance than other primitive materials.

Also surprising is the comparison with the samples from Wild 2 collected by the Stardust mission. Their samples seem to be much more primitive, much less processed, than the samples from Wild 2. This may indicate that there is a huge diversity in the degree of processing of materials in different comets.

(Source: Science Daily online)

New Hydrogen Storage Method

This schematic shows the structure of the new material, $Xe(H_2)_7$. Freely rotating hydrogen molecules (red dumbbells) surround xenon atoms (yellow). (Credit: Image courtesy of Nature Chemistry)

Dr Maddury Somayazulu, a research scientist of Geophysical Laboratory at Carnegie Institution and his research team have found for the first time that high pressure can be used to make a unique hydrogen storage material. The discovery paves the way for an entirely new way to approach the hydrogen storage problem.

They found that the normally unreactive, noble gas xenon combines with molecular hydrogen (H_2) under pressure to form a previously unknown solid with unusual bonding chemistry. The experiments are the first time that has combined these elements to form a stable compound. The discovery debuts a new family of materials, which could boost new hydrogen technologies.

Xenon has some intriguing properties, including its use as an anesthesia, its ability to preserve biological tissues, and its employment in lighting. Xenon is a noble gas, which means that it does not typically react with other elements.

According to Maddury Somayazulu, elements change their configuration when placed under pressure, sort of like passengers readjusting themselves as the elevator becomes full. They subjected a series of gas mixtures of xenon in combination with hydrogen to high pressures in a diamond anvil cell. At about 41,000 times the pressure at sea level (1 atm), the atoms became arranged in a lattice structure dominated by hydrogen, but interspersed with layers of loosely bonded xenon pairs. When we increased pressure, like tuning a radio, the distances between the xenon pairs changed the distances contracted to those observed in dense metallic xenon.

The researchers imaged the compound at varying pressures using X-ray diffraction, infrared and Raman spectroscopy. When they looked at the xenon part of the structure, they realised that the interaction of xenon with the surrounding hydrogen was responsible for the unusual stability and the continuous change in xenon-xenon distances as pressure was adjusted from 41,000 to 255,000 atmospheres.

They were taken off guard by both the structure and stability of this material by changes in electron density at different pressures using single-crystal diffraction. As electron density from the xenon atoms spreads towards the surrounding hydrogen molecules, it seems to stabilise the compound and the xenon pairs.

It is very exciting to come up with new hydrogen rich compounds, not just for our interest in simple molecular systems, but because such discoveries can be the foundation for important new technologies. This hydrogen-rich solid represents a new pathway to forming novel hydrogen storage compounds and the new pressure induced chemistry opens the possibility of synthesising new energetic materials.

(Source: Science Daily online)

Bang on: Success for collider as first atom is smashed

In Geneva, two circulating beams produced the first particle collisions in the world's biggest atom smasher, the Large Hadron Collider (LHC), three days after its restart.

According to director general Rolf Heuer of European Organisation for Nuclear Research (CERN), two beams circulating simultaneously led to collisions at all four detection points. According to scientists it is a great achievement to have come this far in so short a time. In the control rooms of the collider and of the four giant particle detectors, built and staffed by thousands of physicists who have the job of interpreting the data from the beginning of time, there were all-round cheers.

Scientists are looking to the collider inside a 27 km tunnel on the Franco Swiss border to mimic the conditions that followed the Big Bang and help explain the origins of the universe. The project intended to study proton-proton collisions to create conditions following the big bang, is a global Endeavour. CERN has received support from countries around the world, including India, in getting the LHC up and running again.

The LHC is back

On 20 November, 2009, particle beams were once again circulating in the world's most powerful particle accelerator, CERN's Large Hadron Collider (LHC). A clockwise circulating beam was established at 10 pm on that day. This has been an important milestone on the road towards first physics experiment at the LHC, expected in 2010.

It may be recalled that the initial efforts to circulate the beams at LHC in September 2008 was abandoned within nine days, as it suffered a serious malfunction. A failure in an electrical connection led to serious damage, and CERN has to spend over a year in repairing and consolidating the machine to ensure that such an incident cannot happen again.

Decommissioning the LHC began in the summer of 2010, and since then successive milestones have regularly been passed. On October, 8, the LHC reached its operating temperature of 1.9 Kelvin, or about -271 °C. Particles were injected on 23 October, but not circulated. On 7 November, a beam was steered through three octants of the machine and circulating beams were reestablished. The next expected important milestone has been low energy collisions. These would give the experimental collaborations their first collision data, enabling important calibration work to be carried out. This is significant, that all the data they have recorded comes from cosmic rays. Ramping the beams to high energy followed in preparation for collisions at 7 TeV (3.5 TeV per beam) and the first collision between circulating beams at LHC was accomplished after three days of its restart.

For the first time on 23 November 2009, the LHC circulated two beams simultaneously, allowing the operators to test the synchronisation of the beams and giving the experiments their first chance to look for proton-proton collisions. With just one bunch of particles circulating in each direction, the beams can be made to cross in up to two places in the ring. From early in the afternoon, the beams were made to cross at points 1 and 5, home to the ATLAS and CMS detectors, both of which were on the look out for collisions. Later, beams crossed at points 2 and 8, ALICE and LHCb.

Beams were first tuned to produce collisions in the ATLAS detector, which recorded its first candidate for collisions at 14:22 on that day. Later, the beams were optimised for CMS. In the evening, ALICE had the first optimisation, followed by LHCb.

These developments come just three days after the LHC restart, demonstrating the excellent performance of the beam control system. Since the start-up, the operators have been circulating beams around the ring alternately in one direction and then the other at the injection energy of 450 GeV. The beam lifetime has gradually been increased to 10 hours, and on November 23, 2009, the beams were circulating simultaneously in both directions, still at the injection energy.

This undoubtedly marks the beginning of a fantastic era of physics and hopefully discoveries after 20 years' work by the international community to build a machine and detectors of unprecedented complexity and performance. The events so far mark the start of the second half of this incredible voyage of discovery of the secrets of nature.

Next on the schedule is an intense commissioning phase aimed at increasing the beam intensity and accelerating the beams. All being well, the LHC should reach 1.2 TeV per beam by the end of 2009 and would have provided good quantities of collision data for the experiments' calibrations.

(Source: CERN Press release)

Harnessing Waste Heat from Laptop Computers, Cell Phones May Double Battery Time

In everything from computer processor chips to car engines to electric powerplants, the need to get rid of excess heat creates a major source of inefficiency. But new research points the way to a technology that might make it possible to harvest much of that wasted heat and turn it into usable electricity. (Credit: iStockphoto/ Evgeny Kuklev)

The production and usage of electric energy is always associated with some loss of energy in the form of heat. In everything from computer processor chips to car engines to electric power plants, the need to get rid of excess heat creates a major source of inefficiency. But new research might lead to a technology that may make it possible to harvest much of that wasted heat and turn it into usable electricity. That kind of waste energy harvesting might, for example, lead to cellphones with double the talk time, laptop computers that can operate twice as long before needing to be plugged in, or power plants that put out more electricity for a given amount of fuel.

According to Peter Hagelstein, an associate professor of electrical engineering at MIT, USA, existing solid-state devices are not very efficient as far as conversion of heat into electricity is concerned. The major objective of the present research carried out by Hagelstein, with his research student Dennis Wu, has been to find as to how close realistic technology could come to the theoretical limits for the efficiency of such conversion. Theory says that such conversion of energy can never exceed a specific value called the Carnot Limit, based on a 19th-century formula for determining the maximum efficiency that any device can achieve in converting heat into work. But current commercial thermoelectric devices only achieve about one-tenth of that limit. In earlier experiments involving a different new technology, thermal diodes, Hagelstein worked with Yan Kucherov at Naval Research Laboratory, and coworkers to demonstrate the efficiency as high as 40 per cent of the Carnot Limit. Moreover, the calculations show that this new kind of system could ultimately reach as much as 90 percent of that ceiling.

Hagelstein and coworkers started from scratch rather than trying to improve the performance of existing devices. They carried out their analysis using a very simple system in which power was generated by a single quantum dot device, a type of semiconductor in which the electrons and holes, carry the electrical charges in the device, are very tightly confined in all three dimensions. By controlling all aspects of the device, they hoped to better understand how to design the ideal thermal-to-electric converter.

According to Hagelstein, with present systems it is possible to efficiently convert heat into electricity, but with very little power. It is also possible to get plenty of electrical power. You either get high efficiency or high throughput, but the team found that using their new system, it would be possible to get both at once. A key to the improved throughput was reducing the separation between the hot surface and the conversion device. A recent research paper by MIT professor Gang Chen reported on an analysis showing that heat transfer could take place between very closely spaced surfaces at a rate that is orders of magnitude higher than predicted by theory.

The work on the development of this new technology is already in process. This technology could produce a ten-fold improvement in throughput power over existing photovoltaic devices.

The first applications are likely to be in high-value systems such as computer chips, he says, but ultimately it could be useful in a wide variety of applications, including cars, planes and boats. A lot of heat is generated in transport vehicles and a lot of it is lost. If it could be recovered, the transportation technology is going to get more energy efficient.

(Source: Science Daily online)

Crystalline sponge capture CO_2

To sequester carbon dioxide as part of any climate change mitigation strategy, the gas first has to be captured from the flue at a power plant or other source. The next step is just as important: the CO_2 has to be released from whatever captured it so that it can be pumped underground or otherwise stored for the long term. That second step can be costly from an energy standpoint. Materials currently used to capture CO_2 have to be heated to release the gas. But chemists at University of California, Los Angeles, have claimed that a new class of materials developed by them, called metal-organic frameworks (MOFs), hold promise for carbon capture. In the study, Omar Yaghi describes the performance of one MOF, which can free moss of the CO_2 it captures at room temperature. Yaghi described a metal-organic framework as a "crystalline sponge", a hybrid lattice of organic compounds and metal atoms that has a huge internal surface area where gas molecules can be absorbed.

The MOF used in the study contains magnesium atoms, which make just the right environment for binding carbon dioxide. In experiments, the material separated out CO_2 while allowing methane to pass. What was really surprising, though, was that at room temperature 87 per cent of the CO_2 could be released.

(Source: Times of India)

Indians Succeed in Complete Mapping of the Human Genome: Genome *Patri* of an Indian Male

It took the US Human Genome Project more than a decade and $500 million to sequence genes drawn from several volunteers. A team of Indian scientists at the Institute of Genomics and Integrative Biology (IGIB), New Delhi, of the Council for Scientific and Industrial Research (CSIR) has reported mapping of the entire genome of a 52-year-old Indian male from Jharkhand in just 10 months, at a cost of $30,000 or Rs 13.5 lakh. With this achievement, India joins the ranks of the few countries – the US, UK, Canada, China and South Korea, which have successfully sequenced the human genome. Earlier, CSIR scientists had mapped the genetic diversity of the Indian population and also completed the sequencing of genome of the zebra fish, commonly used in laboratories as a model for researching human diseases.

There are greater chances of arriving at a better understanding of the genetic make-up and peculiarities of local populations with countries creating their own DNA sequences; as such knowledge is crucial in comprehending country specific health trends and genetic traits that would otherwise remain largely a mystery. This will enrich knowledge of the different genetic variations that occur in different population groups as well as enable the identification of genes that predispose some to certain diseases. The male, whose genome was decoded by CSIR scientists, is predisposed to heart disease and cancer, and this information has been gleaned from the sequencing of his DNA. The research finding inter alias suggests that Indians are more susceptible to not just for heart diseases, but certain kinds of cancer and mental disorders as well. The technology, therefore, would be invaluable in diagnostics and could be useful in medical treatment as well. Drugs designed to target the affected genes could be formulated, though at present to do so would involve high costs and such an option would be out of reach of the average patient. However, as with all sci-tech breakthroughs, costs are bound to come down – as it has in the case of the genome mapping technology and various computer models – and it is only a matter of time before they become affordable.

According to Sridhar Sivasubbu, who led the project along with Vinod Scaria, they have accomplished mapping of entire genome in a few months whereas the first human genome project which associated scientists from the US, UK, France, Germany, Japan and China took nearly 13 years, from 1990 to 2003. Of course, the first time is always tough, as every attempt involves trial and error, opined Sivasubbu while elaborating on their work. However, it wasn't easy for the two scientists who worked up to 18 hours a day in the lab. We would never have been there, never done it without having a totally new set of analytical and computational skills, which has been one of the biggest challenges before us, asserts Sivasubbu. Once this was attained, there was no looking back. According to Scaria since the genome technology was readily available to them, it took much less time. In spite of this, Sivasubbu and Scaria toiled for long hours on their mission to map the 310 crore (3.1 billion) base pairs that constituted the Jharkhand man's DNA utilising the facilities of a supercomputer, capable of analysing data at the speed of four trillion operations per second, that their institute had acquired in 2006. Although the supercomputer speeded up analysis by more than 500 times compared to ordinary computers, scientists had to perform the manual work of immobilising the sample on glass slide, adding one nucleotide at a time and photographing it using a high-resolution digital camera. Each nucleotide was identified by peculiar colour it emits.

Law and ethical resolutions tend to lag behind implementation of scientific and technological advances, and the relatively new field of DNA sequencing is no exception. What if an individual's genome *patri* (horoscope) were accessible to employers and insurance companies who might use the information against the employee or clients? Should an individual choose to reveal details of his genetic 'horoscope' to his family and friends or keep it private? Would the knowledge impact the individual's own perspective of life and how he lives it? There are plenty of issues that may crop up for debate, especially since predisposition to a disease does not mean it would actually manifest in the person.

(Source: Times of India)

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WEB WATCH

In this Section, we present websites and a brief introduction about them. Inclusion of a site does not imply that School Science endorses the content of the site. Sites have been suggested on the basis of their possible utility to school systems.

- **Nanotechnology**
  http://www.crnano.org

  This website of Centre for Responsible Nanotechnology talks about the meaning of nanotechnology, four generations of nanotechnology development, nanotechnology as general purpose technology and as dual-use technology. It provides links to related topics, for example, Nanotechnology Basics for students and other learners, Nano-simulations, and the future of nanotechnology.

- **Nobel Prizes for 2009**
  http://www.nobelprize.org

  This website provides details, life and work of scientists awarded, Nobel Prize in Physics, Chemistry, Phyisiology or Medicine for the year 2009. It also has details about Alfred Nobel, Nobel organisation and life and works of all Nobel Laureates.

- **Holography**
  http://www.holophile.com

  This website is good resource for holography. It gives details of the history of holography, biography of its inventor Dennis Gabor's biography, and the science of holography.

- **Simple Holography - The Easiest way to make Holographs**
  http://www.holokits.com/- a-simple holography.htm

  This is a write-up by T. H. Jeong, Raymond Ro, Riley Aumiller and M. Iwasaki with contribution from Jeff Blythe. It explains, in simple steps, how to make reflection and transmission holograms. It also has a link to another useful write up by the authors on, "Teaching Holography in classrooms."

- **Misconceptions in Science**
  http://www.indiana.edu

  What are misconceptions? How do children form misconcepts? How can teachers best address students' science misconcepion? All this and more are provided in this website. It also has many links that provides a list of references of research studies on misconceptions.

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YOU'VE ASKED

1. Question: **Conversion of milkinto curdis due to thereaction of micro organisms, but on adding chilly orlemon drops to kilk, it is not counvertedin to curd? Whiisit so?**

P.S.Pooja
JawaharNavodaya Vidyalaya
Galibredu, Madikeri,Kodagu
Karnataka

Answer: The milk is converted into curd by the action of bacteria called *Lactobacillus*. *Lactobacillus* is a kind of bacteria which can convert a sugar into an alcohol and then into an acid by means of anaerobic respiration. When milk is heated to a temperature of 30-40 degrees celsius and a small amount of curd is added to it, the *lactobacillus* present in the curd sampleget activated and multiply. These convert the lactose, a kind of sugar, present in the milk into lactic acid, which imparts the sour taste to curd. Thus, these bacteria increase the acidity of milk and at the same time cause the milk proteins (casein) to tangle into solid masses, or curds. On the other hand, when we put the lemon drops or chilli, the milk is not converted into curd but the fats present in the milk get coagulated and its water content gets separated. The citric acid present in lemon juice converts unsaturated fats of milk into saturated fats, which begin to form lumps. This process is known as coagulation. Other solid (colloids) particles, such as those of proteins present in the milk, also get trapped in the process of formation of lumps of fats and the resultant product is commonly known as cottage cheese or *paneer*.

2.Question: **In places with hot climate it is advised that outer walls of houses be painted white. Explain.**

M. Rama Rao
S/O Shri Durgaraju
D. No. 3-115 (near the Post office)
Puwala Street
Kothapalli 533 285
Gokauaram (M), East Godawari, Andhra Pradesh

Answer: White or light coloured surfaces are good reflectors of light and heat. Since sunlight carries both light and heat, the outer walls of a building exposed to sunlight become hot by absorbing its heat and in turn rooms inside the building also get heated. However, if the outer walls of the building are painted white or with a light shade, a greater part of the heat gets reflected back. This helps in keeping inside of the building comparatively cool, particularly during summers.

3. Question: **Who publishes red data book?**

Aishwarya Joshi
B 285, Sector 20, NOIDA
Gautam BudhNagar (U.P.)

Answer: Red Data Book provides the list of endangered animal and plant species. At international level it is prepared by the International Union of Conservation of Nature or Natural Resources (IUCN).For India the Red Data Bookfor endangered animals is published by the Zoological Survey of India, Kolkata while that for plants is published by Botanical Survey of India, Kolkata.

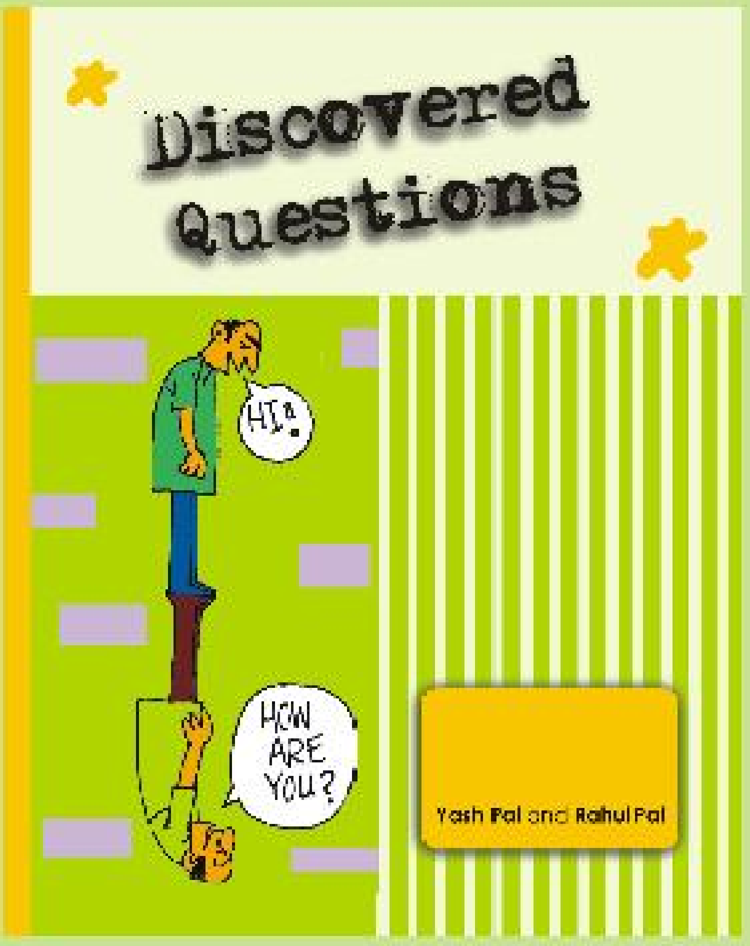
4.Question: **Why the region above hills, the sky and the water in oceans and deep rivers/lakes looks blue from a distance?**

Wangtum Lowung
Class VI
C/o Principal
Ramakrishna Mission School
Narottam Nagar
Arunachal Pradesh

Answer: You may be aware that sunlight or the white light is a mixture of light of seven different colours; namely red, orange, yellow, green, blue, indigo and violet. When a ray of light enters from one transparent medium like air into another such medium like glass or water it bends from its straight line path in the first medium and begins to move in a different direction, although along a straight line path, in the other medium. This phenomenon is called refraction. However, in the case of white light or sunlight the extent to which different colours in a ray light bend is different. As a result, a thin beam of white light on entering a drop of water or a glass prism splits into its component colours and gives rise to a spectrum on emerging out on the other side of it. This phenomenon is known as dispersion of light.
However, if the size of the water drop is very small, say the size of a dust particle, the light exhibits another phenomenon called scattering. The light falling on such small particles is first absorbed by them and then emitted. The process of absorption and emission of light takes place in less than a

microsecond. However, the direction in which the light gets reemitted is different from its initial direction of propagation, the angle between the initial direction of propagation and that of scattered light is called angle of scattering. The brightness we observe around us after sunrise even if a place is not directly illuminated by sunlight, is due to scattering of light by the dust particles present in air. The light of different colours present in sunlight too gets scattered in different directions, angle of scattering is different for light of different colours. But, we usually do not perceive it, as our eyes receive light from all possible angles due to scattering by a large number of particles and the combined effect of these give us the impression of white light. The blue colour of the sky is one of the most familiar examples to perceive the effect of difference in the angle of scattering for light of different colours. As the sunlight enters upper regions of atmosphere, the fine dust particles present there scatter light of different colours in different directions. The red light is scattered the largest angle while the violet and blue are scattered least. As a result, red, orange, yellow and green components of sunlight get scattered away while blue, indigo and violet components get scattered towards the surface of the earth. As our eyes are more efficient to perceive blue colour as compared to indigo and violet, we see the sky as blue. The region above hills appears blue for a similar reason though the scattering in this case is by the fine droplets of water that evaporates from the soil or transpires from the trees that cover it.

When sunlight falls on the surface of water in oceans or deep lakes/rivers, a fraction of light gets reflected, a part gets refracted while rest of it gets absorbed. Water absorbs more of the red light present in sunlight; the water also enhances the scattering of blue light. The part of the sunlight that penetrates the water is scattered by its particles and also by ripples in the water. In deep water, much of the sunlight is scattered by the oxygen dissolved in the water, and this scatters more of the blue light. That is why the water in oceans and deep lakes or rivers appears blue to us. This phenomenon inspired Chandrasekhar Venkata Raman to investigate scattering of light which led to the discovery of the phenomenon now known as Raman Effect. Raman was awarded the Nobel Prize in 1930 for his work on light.



Discovered Questions

Yash Pal and Rahul Pal

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To Our Contributors

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Articles suitable to the objectives mentioned above are invited for publication. An article sent for publication should normally not exceed ten typed pages and it should be exclusive to this journal. A hard copy of the article including illustrations, if any, along with a soft copy should be submitted in CD. Photographs (if not digital) should be at least of postcard size on glossy paper and should be properly packed to avoid damage in transit. The publisher will not take any responsibility or liability for copy right infringement. The contributors therefore should provide copy right permission, wherever applicable, and submit the same along with the article.

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