Notes and News

Ig Nobel Prizes 2017: First Laugh and Then Think

Never heard about it? Allow me to explain it. Ig Nobel Prizes (Twitter: *#IgNobel*), a parody of Nobel Prizes, are awarded every year from 1991 for ten real achievements in 'improbable research' that 'first make people laugh, and then make them think'. In the words of Marc Abrahams, Editor of the science humour magazine, *Annals of Improbable Research* (*AIR*) where these results are published and who organise the award giving ceremony, "*the prizes are intended to celebrate the unusual, honour the imaginative, and spur people's interest in science, medicine, and technology*". The prizes are awarded each year in mid-September before the announcements for the real Nobel Prizes are made. The ceremony, co-sponsored by the Harvard-Radcliffe Society of Physics Students and the Harvard-Radcliffe Science Fiction Association, takes place at the Sanders Theater of the Harvard University that accommodates 1200 spectators. Winners are given 60 seconds each to explain their work, and then the Prizes are handed over by some genuine Nobel Laureates. Subsequently, the winners make full presentations of their work at MIT.

The 2017 Ig Nobel Prizes were awarded on Thursday night, September 14 at the 27th First Annual Ig Nobel Prize Ceremony, also webcast, at the Sanders Theater at 6.00 p.m. The ceremony was presided over by Marc Abrahams and included the premiere of 'The Incompetent Opera' – a show about the 'Peter Principle' and the 'Dunning-Kruger Effect', both of which try to explain why incompetent people rise to the top (improbable indeed!). Each of the awardees received a cash prize of 10 trillion dollars in the form of a Zimbabwean bill whose value is just a few U.S. cents. Clearly, the awards come with little cash, but much cachet.

"The Stinker", the official mascot of the Ig Nobel Prizes.

The disciplines, the winners, the countries whose researchers were involved in the work, their achievements and the related publications of the results are cited below for each discipline.

Physics: M.-A. Fardin (Paris Diderot University, France) – For use of fluid dynamics to probe the question as to whether a cat can behave both as a solid and as a liquid. His answer was 'yes, depending on the circumstances'. Based on rheological studies, Fardin concluded that cats can be simultaneously a solid and a liquid because of their ability to adopt the shape of their container (*Rheology Bulletin*, 2014).

Fluid Dynamics: J. Han (a second year student, University of Virginia, Charlottesville, USA) – For his analysis (as a high school student in South Korea) on why people tend to spill coffee as they walk. He studied the dynamics of liquid-sloshing and recommended that gripping a coffee cup by the body, rather than by its handle, or by walking backwards prevents spilling (*Achievements in the Life Sciences*, 2016).

Biology: K. Yoshizawa, R. Ferreira, Y. Kamimura and C. Lienhard (Japan, Brazil, Switzerland) - For their discovery of spiny, penis-like female organ and a male vagina in one type of Brazilian cave-dwelling insect whose copulation can last up to 70 hours (*Current Biology*, 2014).

Nutrition: F. Ito, E. Bernard and R. Torres (Brazil, Canada, Spain) - For the first scientific report of human blood in the diet of the hairy-legged vampire bat (*Acta Chiropterologica*).

Medicine: J.-P. Royet, D. Meunier, N. Torquet, A.-M. Mouly and T. Jiang (France, U.K.) - For using advanced brain-scanning technology to measure the extent to which some people are disgusted by cheese (*Frontiers in Human Neuroscience*, 2016).

Anatomy: J. Heathcote (U.K.) - For his medical research on why old men tend to have bigger ears (*British Medical Journal*, 1995).

Obstetrics: M. López-Teijón, Á. García-Faura, A. Prats-Galino and L. P. Aniorte (Spain) - For showing that a developing human foetus responds more strongly to music that is played electromechanically inside the mother's vagina than to music that is played electromechanically on the mother's belly (*Ultrasound*, 2015; also, patented). A product, named 'Babypod', based on this research, is also available.

Economics: M. Rockloff and N. Greer (Australia, USA) - for their experiments to see how contact with a live crocodile intensifies a person's willingness to gamble in electronic machines (*Journal of Gambling Studies*, 2010).

Cognition: M. Martini, I. Bufalari, Maria A. Stazi and Salvatore M. Aglioti (Italy, Spain, U.K.) - For demonstrating that many identical twins cannot tell themselves apart visually (*PLoS ONE*, 2015).

Peace: M. Puhan, A. Suarez, C. Lo Cascio, A. Zahn, M. Heitz and O. Braendli (Switzerland, Canada, The Netherlands, USA) - For demonstrating that regular playing of a didgeridoo, an Australian aboriginal wind instrument, is an effective treatment for obstructive sleep apnoea and snoring (*British Medical Journal*, 2006).

Nature has rightly remarked that "The Ig Nobel awards are arguably the highlight of the scientific calendar." ❐

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Marie Curie: The Greatest Chemist of All Time

We, the human beings, are always curious to know 'who is the greatest in all walks of life' in order to motivate ourselves to strive for betterment in our respective fields. Consciously or in our subconscious mind, we always want to know the greatest, the biggest and the fastest. It is easy to quantify information to ascertain the biggest (in the case of objects) and the fastest (in the case of certain sports, animals, etc.), but it is nearly impossible to measure the greatness or brilliance of a person in humanitarian, literary and scientific fields because the matter rests outside the domain of mere statistics. We need to assess their achievements (keeping in mind the environment they faced and the obstacles they overcame) and the lasting and inspiring effect of their legacy on human civilisation. Further, there is no acceptable way to compare between different disciplines.

One Kit Chapman (@ChemistryKit) decided in early November, 2017 to hold a competition on Twitter to pick '**the greatest chemist of all time**'. Based on the criteria stated above, he decided to make a list of 24 chemists and left another 8 slots as 'wildcard' entries. A few names like Marie Curie, Michael Faraday and Humphry Davy were obvious choices right from the start. The names of Irène Joliot-Curie, Gilbert Newton Lewis and Jacobus van't Hoff were later included based on legacy. Chapman included the name of Glenn Seaborg because he discovered plutonium and since the element 106, i.e. seaborgium was named after him. When Chapman called for names, the response was enormous and he had a tough time to select the list because debates on some of the names raged in social media. He was in a fix, for example, to make a choice between Roald Hoffmann, a modern wizard in chemistry and Jacob Barzelius, a Swedish chemist of the 18th century. He retained the name of Hoffmann. Also, the names of Michael Faraday and Louis Pasteur were demanded to be stricken out from the list because they considered Faraday as a physicist and Pasteur as a biologist. But both the names were retained. Chapman, however, agreed to the call for rejection of only one candidate, viz. that of Ernest Rutherford because Rutherford himself continued to insist around 1930s in Cambridge that he was not a chemist. Controversy also cropped up on the selection of Fritz Haber, the celebrated inventor of the synthesis of ammonia from nitrogen and hydrogen – a discovery that led to fertilisers that are so important to the modern world. Regrettably, however, Haber also discovered chemical warfare. In the end, Haber remained in the fray.

All the 32 chemists were clubbed into 8 groups, each comprising the names of 4 chemists. There was a round robin league between groups I-IV and between V-VIII. Votes continued for two weeks. The results were declared at 1.01 AM on December 4, 2017 in #ChemGOAT. In gr. I (421 votes), Marie Curie (61%) was victorious over Davy (14%), Dorothy Hodgkin (13%) and Svante Arrhenius (12%). In gr. II (404 votes), Faraday (45%) won over R.B. Woodward (29%), Robert Boyle (13%) and Emil Fischer (13%). In gr. III (254 votes), Pasteur (54%) topped the list of Joseph Priestly (26%), Robert Bunsen (12%) and Henry Moseley (8%). In gr. IV (496 votes), Dimitri Mendeleev (38%) ranked first, followed by van't Hoff (23%), Amedeo Avogadro (22%) and Hoffmann (17%). Next, in the winner of one group *vs* runner-up of another group competition, Curie (78%) won over Woodward (22%) (total votes: 260), Pasteur (52%)

over van't Hoff (48%) (total: 259 votes) , Faraday (76%) over Davy (24%) (total: 267 votes) and Mendeleev (72%) over Priestley (28%) (total: 159 votes). In the quarter finals, Curie (76%) triumphed over Pasteur (24%) (total: 196 votes), and Faraday (54%) triumphed over Mendeleev (46%) (total: 246 votes). Curie and Faraday thus emerged to be the two semi-finalists from grs. I-IV.

Marie Curie, N.L.

In gr. V (186 votes), Antoine Lavoisier (49%) defeated August Kekulé (28%), Joliot-Curie (13%) and William Ramsay (10%). In gr. VI (271 votes), Haber (30%) was atop Josiah Gibbs (30%), E.J. Corey (21%) and Mildred Dresselhaus (19%). In gr. VII (283 votes), Rosalind Franklin (43%) scored more than G.N. Lewis (27%), John Dalton (23%) and Friedrich Wöhler (7%). In gr. VIII (218 votes), Linus Pauling (65%) was a clear winner amongst Frederick Sanger (20%), Seaborg (8%) and George Whitesides (7%). In the next round, Lavoisier (55%) defeated Gibbs (45%) (total: 124 votes), Franklin (64%) won over Sanger (36%) (total: 136 votes), Haber (54%) beat Kekulé (46%) (total: 122 votes), and Pauling (60%) went ahead of Lewis (40%) (total: 159 votes). In the quarter finals, Lavoisier (54%) defeated Franklin (46%) (total: 138 votes) while Pauling (68%) triumphed over Haber (32%) (total: 252 votes). Thus, Lavoisier and Pauling were the two semi-finalists from grs. V-VIII.

In the two semi-finals, Curie, pitted against Lavoisier, had a comfortable margin (70% vs 30%) (total: 351 votes), and Faraday, pitted against Pauling, won by a lesser margin (59% vs 41%) (total votes: 378). In the final contest (740 votes), Marie Curie had a landslide victory (72%) over Michael faraday (28%).

The greatness of marie Curie is embedded in her life and work. Born in Warsaw, Poland on November 7, 1867, Maria Sklodowska (the maiden name of Marie Curie) had her early education in Russian Poland, received informal higher education from Warsaw's underground Floating University or Flying University, left for Paris (in 1891) where she struggled to get higher education in Physics and Mathematics. In July, 1895, she married Pierre Curie, then a Lecturer, and became Madame Marie Curie. Slowly she rose to eminence through her research. She coined the name 'radioactivity', discovered two elements – polonium (in July, 1898; 0.1 mg from a ton of pitchblende) and radium (in December, 1898) - and won Nobel Prizes twice – the first (for physics) along with Pierre Curie and Henri Becquerel in 1903 and the second (for chemistry) in 1911 on her own. Element 96 was named 'curium' after her. Despite the tragic death of her husband in a traffic accident in 1906, she continued research and reared her daughters well. Indeed, her eldest daughter, Irène Joliot-Curie (along with Marie's son-in-law, Frédérick Joliot-Curie) was also awarded Nobel Prize in Chemistry in 1935 – a legacy was born. During the 1st World War, Marie Curie showed her patriotism by running radiology training courses for doctors and nurses and by organising a mobile X-ray team that served in the field hospitals in the warfront. She died on July 4, 1934 in a sanatorium in France when she was suffering from aplastic anemia arising out of exposure to radiation for a long time during her research with radioactive substances and during her work with mobile X-ray machines in field hospitals during the 1st World War.

Once voted "the most inspirational woman in science" in a 2009 poll carried out by *New Scientist*, Marie Curie continues to be an inspiration to generations of scientists. She has deservedly been crowned "the Greatest Chemist of All Time", albeit on a Twitter pole. ❐

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Students of R.K. Mission Vivekananda English School visit at CSIR-NML

A group of 64 students of class IX & X standards from R.K. Mission Vivekananda English School, Sakchi accompanied by three teachers were visited CSIR-National Metallurgical Laboratory, Jamshedpur and interacted with scientists and research scholars under the aegis of CSIR-NML-School Interactive programme. The students were thrilled to visit the laboratory and interact with working group.

The programme was scheduled for three hours. Dr. P. N. Mishra, Principal Scientist, welcome the students, teachers and brief about the programme, discussed an overview of CSIR and NML, its contributions in different branches of Science & Technology. He defined science, science & technology, development of science & technology in Indian perspectives, also explains about natural resources like ores, minerals, rocks and its value for the development

of our Nation. Further, a laboratory visit programme was organized in two groups lead by Dr. P.N. Mishra and Sri S.N. Hembram which helped students to interact with working scientists and technical officers.

During the interactive session, number of students asked different questions on minerals, ores, origin of coal, the evolutionary history behind the formation of metal, metals forging, rolling, and heat treatment etc. Teachers and students requested for their next visit to the laboratory to gain deeper knowledge. Teachers expressed their view and was satisfied to know about the consistent effort and research emphasis in various sectors for the ultimate development of India. At last, teachers acknowledged and extended thanks to CSIR-NML authorities for providing opportunity to visit NML and observe various facilities. ❐

PCSIR-NML

Psycho-Neuro-Endocrino-Immune System: An Integrated Area of Study

It is well recognized now that entire physiological system of humans is under the regulation of Neuro-endocrine system that comprises endocrine system and nervous system particularly the brain. Recently, it has been found out that, immune cells of the body play role not only in defense system but also in neuronal functions such as regulation of cognitive functions and mood through certain chemical secretions that bind to specific receptors located in various brain components. Brain is spontaneously functional through continuous processing of diverse informations, conceived as neuronal inputs, consolidated, and stored in form of memory in higher cortical brain centres, which are collectively referred to as mind which is studied in Psychology. Thus Psycho-neurology is an integrated term**.** Recent developments in the field of Neurosciences, Molecular Endocrinology and Immunology have established the fact that these systems act in highly coordinated and integrated way to control the physiological systems of the body leading to homeostasis that is required for survival. A new research done by Professor Jonathan Kinspin and his team at 'Centre for Brain, Immunology and Glia', Virginia University, has shown that immune system is directly related to brain, and various immune-molecules including- interferons and cytokines secreted from T-Cells have direct regulation over neuronal connectivity and social behaviour.

The endocrine role of this complex regulatory system begins with Hypothalamus which is the part of diencephalon (a part of fore brain). Hypothalamus regulates the pituitary gland by secreting the neuro-peptides as 'releasing factors' that have distinct receptors on pituitary cells. Under the command of hypothalamus, pituitary gland secrets peptide hormones that further regulate major endocrine glands like thyroid, adrenal cortex, testis, and ovary. Most of the glands and hormones under this regulatory mechanism are responsible for promoting growth, differentiation and metabolism of the body, which is essential for routine body physiology. The ultimate goal of this regulatory mechanism is to maintain the homeostasis of the body with a balanced metabolism.

Hypothalamus is also considered as the centre of emotion and is one of the oldest parts of limbic system, a set of neuronal circuitry within brain responsible for regulation of emotional behaviour. It is connected to higher cortical centres through intricate neuronal networks.

Once the processed neuronal signal from cortical centres is passed on to hypothalamus, it gets switched on and along with the stimulation of sympathetic and parasympathetic nervous system; it secretes hormones to regulate the endocrine system through discrete axes or chemical pathways. There are basically three pathways:

1- Hypothalamo-pituitary-adrenal axis (HPA axis).

2- Hypothalamo-pituitary-thyroid axis (HPT axis).

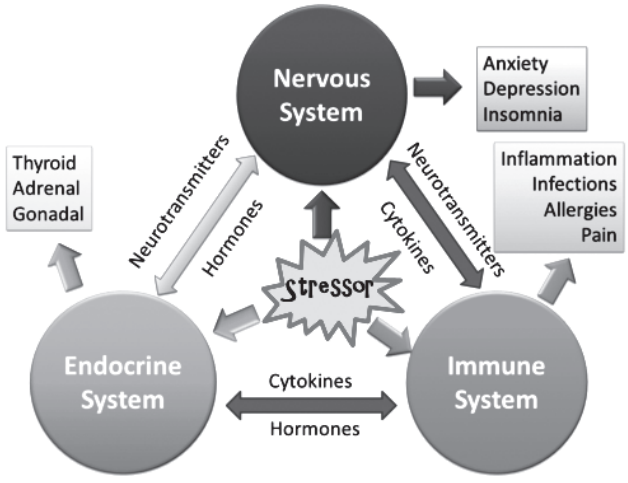
3- Hypothalamic –vasopressin axis.

The HPA axis begins with the release of Neuropeptides from the Neurosecretary cells of hypothalamus. These specific releasing factors have their corresponding receptors on the cells of pituitary. In HPA axis the hypothalamus secretes corticotropin releasing factor (CRF) which stimulates the pituitary cells to release Adreno Cortico Tropic Hormone (ACTH), which further stimulates the adrenal cortical cells to release Cortisol and Aldosterone. Cortisol which is considered as stress hormone has prolonged effects on metabolism and can persist in high level up to days or weeks in stress condition. It induces glycogenolysis in liver and muscles (breakdown of glycogen in to glucose for cellular respiration) and in prolonged effect, it promotes breakdown of fat in adipose tissues and breakdown of proteins in muscles called as gluconeogenesis.. It also suppresses the immune cells and most probably leads to destruction of white blood corpuscles to provide continuous fuel supply in form of glucose and to prevent the energy expenditure in other physiological processes for survival of the body.

Aldosterone which is secreted 100 times less in comparison to Cortisol but it promotes the absorption of sodium ions thus maintaining the osmotic pressure of the blood and increases blood pressure thereby maintaining mineral homeostasis which is essential for survival.

Along with HPA axis, the HPT axis is also switched on by the same regulatory mechanism. Thyrotropin Releasing Factor(TRF) from hypothalamus stimulates the pituitary cells to secrete thyroid stimulating hormone (TSH), which further stimulates the thyroid cells to secrete thyroxin ,that increases the metabolism through glycogenolysis (break down of glycogen in to glucose) , gluconeogenesis (break down of proteins and lipids for glucose generation) for the continuous supply of energy fuel to the cells.

The supra optic nucleus (SON) of the anterior hypothalamus directly sends the neuronal innervations to the posterior pituitary and releases vasopressin or Anti Diuretic Hormone (ADH). This hormone acts on tubular cells of kidney and promotes water reabsorption in order to maintain the osmotic balance of blood along with Aldosterone. During stress condition ADH promotes vasoconstriction thus contributing in enhanced blood pressure.



Thus nervous system, endocrine system and the immune system have very intricate but highly coordinated integration to control rest of the physiological systems of body. Therefore the term 'Psycho-neuro-endocrino-immunology' seems to be relevant for this interdisciplinary area of study. ❐

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Disulfiram (Antabuse) : Old Alcohol-aversion Drug Shows Anticancer Promise

Disulfiram, bearing the brand name 'Antabuse', has been in use for decades to treat chronic alcohol abuse. Though the drug does not cure chronic addiction to alcohol, it discourages the addicts from consuming alcohol.

The present story has its origin in a 1971 case report. A female patient suffering from bone cancer had, at the age of 38, cancer spread to her bones. Depressed, she became an alcoholic. The doctors stopped the treatment of her cancer and prescribe to her the alcohol-aversion drug 'Antabuse' to get rid of her drinking habit. Surprisingly, the patient survived ten more years before she fell from a window and died. An autopsy of the body revealed that her bone tumours had melted away, and only a few cancer cells were left in her bone marrow - an unexpected finding indeed!

Since the 1970s, scientists conducted studies on the anticancer efficacy disulfiram and found out that it killed cancer cells and slowed the growth of tumour in animals. The results of a clinical trial published in 1993 revealed that the drug also increased the survival of women who had their breast tumours removed. Despite these revelations, the compound did not receive much attention as an anticancer drug in the subsequent years.

In a recent collaborative Danish-Czech-U.S. study, led by the cancer biologist Jiri Bartek of the Danish Cancer Society Research Center in Copenhagen and published in *Nature* (doi: 10.1038/nature25016; published online Dec 06, 2017), searched through the cancer register of Denmark which recorded more than 2,40,000 cancer cases diagnosed during 2000-2013 and the medications they took. They found out that the death rate from cancer was lower by 34% for those patients (>3,000) who took Antabuse during cancer treatment compared to those (<2,000) who stopped taking it. Clearly, the drug appeared to be 'an equal opportunity anti-cancer weapon', and the benefits hold good for prostrate, breast and colon cancers as well as cancer overall.

It had earlier been known that disulfiram, combined with a copper supplement, slows down the growth of breast cancer in animals. The present researchers confirmed this observation in mice and also studied the metabolism of the drug. They showed that ditiocarb, the main metabolite of disulfiram in mice, blocks the machinery that cells use to dispose of misfolded and unneeded proteins. In the

words of Bartek, "*everything is frozen*." Partly because of the resulting protein build-up, the cancer cells become stressed and die.

These researchers also identified the molecular target of the tumour-suppressing effect of disulfiram by functional and biophysical studies. They also found out why normal cells are not harmed by disulfiram even when patients take this drug for years. They couldn't, however, explain why the copper metabolite is ten times more abundant in tumour tissue compared to that in other tissues.

On a negative note, cancer biologist Thomas Helleday of Karolinska Institute, Stockholm has cautioned that disulfiram is probably not a cure most cancer patients, but it helps extend the lives of patients with metastatic cancer. Bartek's group is currently testing a disulfiram-copper combo as a cure for metastatic breast and colon cancers and one type of brain cancer.

As per a recent WHO estimate, the number of new cancer patients may rise by 70% in the next two decades. Cancer is indeed the second leading cause of death worldwide. This situation necessitates continued search for newer anticancer drugs. But since this an expensive and time-consuming venture, the repurposing of disulfiram as a drug to extend the lives of even metastatic cancer-afflicted patients is definitely an additional safe, cost-effective and time-saving avenue. ❐

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Homage to Prof. Hargovind Khorana on 50th Nobel Award year

Nobel Prize winners from India comprise three categories, namely Indian citizens who won Nobel Prize, Indian born Nobel Laureates and Nobel Laureates with Indian link. Prof. Hargovind Khorana is included in second category; the other two in it are astrophysicist Prof. Subrahmanyan Chandrasekhar and structural biologist Prof. Venkatraman Ramakrishnan. Prof. H. Khorana (1922-2011), the Indian-American biochemist and illustrious figure in molecular biology, won the Nobel Prize in Physiology/ Medicine in 1968 (with Marshall Nirenberg and Robert Holley) for giving details of how genetic information is translated into proteins, which carry out functions in living cell. Prof. Khorana's work on decoding how cells read the language of RNA written in structures represented by letters A, C, U, and G, is undoubtedly an important scientific landmark of twentieth century.

Interpretation of the genetic code and elucidation of its function are highlights of explosive progress of molecular biology that occurred during 1948 and 1968. It led to an understanding of details of the mechanism of inheritance. Beginning from August 1961, in less than five years, all the details of genetic code were established, mainly from the works of H. Khorana and M. Nirenberg. Prof. Khorana systematically devised methods for synthesis of well-defined nucleic acid molecules, with every building block in its exact position. These were a pre-requisite for final solution of genetic code. In the 1950s, it was established that genetic information is transferred from DNA to RNA, to protein; one sequence of three nucleotides in DNA corresponds to an amino acid within a protein. Prof. Khorana significantly contributed to 'cracking of genetic code' by building different RNA chains with help of enzymes, using which, he was able to produce proteins. Amino acid sequences of these proteins helped to interpret/ decipher genetic code. He initiated the work on the chemical synthesis of ribotrinucleotides for protein synthesis at University of British Columbia in 1952.

Prof. Khorana used deoxyribopolynucleotide polymer, or DNA polymer to study transfer of genetic information from DNA to RNA in form of RNA transcript, as well as translation of genetic information in form of protein. He used DNA polymer in which base sequence was so designed to synthesize a predictable kind of protein. He started his experiments on genetic message in form of a short deoxyribopolynucleotide chain containing repeated nucleotide sequences. He used these short polynucleotide chains as templates for synthesizing larger DNA polymers of repeating sequences, which, thereafter were used as templates for synthesis of messenger RNA molecules. This RNA transcript produced through complementary base pairing rule also showed a repeating nucleotide sequence. One of the first synthetic messenger RNA produced by him with repeating sequence was AAG. It was formed to direct the synthesis of three different homopolypeptides containing a repeating sequence of a single amino acid - lysine, arginine and glutamic acid. In order to specify which one of the three possible codons AAG, AGA and GAA code for which amino acid, by using trinucleotide technique of binding of amino acid to ribosome, Prof. Khorana was able to find out that AGA codes for arginine, AAG for lysine and GAA for glutamic acid.

Using a repeated dinucleotide sequence of UCUCUC, he found it to direct the synthesis of amino acids serine and leucine, coded by UCU and CUC. He helped determine

which combinations of nucleotides form which specific amino acids. He found genetic code to be a triplet code and in this way, by arranging the four letters into distinct patterns, he identified 64 codons of genetic code, using synthetic messengers with repeated base sequences. Codons instruct the cell to start and stop production of proteins. His work unambiguously confirmed that the genetic code consisted of 64 distinct three-letter words. It was the theory of central dogma of molecular biology, which he mapped out. In 1972, Prof. Khorana achieved the synthesis of first artificial copy of a gene (yeast gene) and in 1976, this artificial gene could be made to function in a bacterial cell. For amplification of the synthetic gene, he proposed a series of steps similar to Polymerase Chain Reaction, long before it became a routine method. He was one of the first biologists to outline the possibility of gene manipulation, which he did before any individual gene could be characterized from any organism.

About Prof. Khorana's scientific curiosity, it is said that only three days before he died, he was talking with one of his colleague about glucose and the human brain lying in hospital bed. Ms. J. Khorana, sister of Prof. Khorana, remarked: "Even while doing researches, Prof. Khorana was always really interested in education and young people. After he retired, research students would come to visit and he loved to talk to them about the work they were doing. He was very loyal to them, and they were loyal to him too". Having a humble beginning in a small village named Raipur in Khanewala district of western Punjab (this region was allocated to Pakistan after the partition of British India) and with strong aptitude for science, Prof. Khorana could rise to have great influence over young scientists at MIT and other institutes. He is known for his modest behaviour and humility, was awarded Padma Vibhusan in 1972. He was the first to demonstrate the role of nucleotides in protein synthesis, and also helped develop custom designed pieces of artificial gene and methods that anticipated the invention of PCR.

From early on, Prof. Khorana did not stick to the rigid boundaries of academic disciplines and his work was to take him across the fields of chemistry, biology and physics. Whenever he undertook a new project, he secured time in other laboratories so that he could master the techniques that he needed to carry an idea forward. In 1960, he moved to the Enzyme Institute at the University of Wisconsin-Madison where he began working on the genetic code and chemical synthesis of a transfer-RNA gene; during this time he determined how the synthesis of proteins is controlled by nucleotides and nucleic acids. In his Nobel Lecture on 'Nucleic Acid Synthesis in the Study of Genetic Code', delivered on 12th December, 1968, Prof. Khorana mentioned: "…… The problem of the genetic code at least in the restricted one-dimensional sense (linear correlation of nucleotide sequence of polynucleotides with that of the amino acid sequence of polypeptides) would appear to have been solved. This knowledge would serve as a basis for further work in molecular and developmental biology. It has been a most satisfying experience in the lives of many of us, who have worked on the problem of codon assignments, to see complete agreement reached in regard to general structure of genetic code". In 2018, we have reached on the fiftieth year of Nobel Award of Prof. Hargovind Khorana. ❐

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Fortified Banana to Fight Vitamin A-Deficiency

Vitamin A deficiency is a severe condition, particularly in malnourished children and women in developing countries. It is the leading cause of preventable blindness – and can significantly increase the risk of disease from severe infections. Approximately one third of the world's pre-school-age population is estimated to be vitamin A deficient; with highest prevalence (44-50%) being reported in regions of Africa and South-East Asia. According to a 2013 report published in the *Journal of Health, Population and Nutrition*, India has the highest prevalence of clinical and subclinical vitamin A deficiency among South Asian countries; 62% of pre-school children were reported to be deficient in vitamin A. These dramatic results suggested high mortality rate, leading to an annual 3,30,000 child deaths. Women of childbearing age were also reported to excessively suffer from night blindness.

Treatment for subclinical vitamin A deficiency includes the consumption of vitamin A-rich foods, such as liver, meat, chicken, eggs, fortified milk, carrots, mangoes, sweet potatoes, and leafy green vegetables. It may also be treated by daily oral supplements of vitamin A. Now there is simpler way of preventing vitamin A deficiency – by eating genetically modified banana fortified with provitamin-A, which is converted into a vitamin when digested. Scientists in Australia have developed the fortified 'super' banana, rich in pro-vitamin A, which they say could save the lives of the hundreds of thousands of children who die from this deficiency every year. The golden-fleshed fruit was created by researchers from Centre for Tropical

Crops and Biocommodities, Queensland University of Technology, Brisbane, who have been growing the biofortified bananas for over the last 10 years.

The provitamin A-rich bananas were created through genetic engineering. The researchers took genes from a natural species of provitamin A-rich banana found in Papa New Guinea, which only grows in small bunches. The genes were then fused with the genes of native banana sold in the market. According to the researchers, the result is an unusual orange-coloured banana that could significantly increase the vitamin-A intake of the consumer (*Plant Biotechnology Journal*, April 2017 | DOI: 10.1111/pbi.12650).

Bananas are the world's most important fruit crop and one of the top 10 crops by production. They are widely grown in the wet tropics and subtropics forming an important dietary component both raw as a dessert fruit and cooked often as the major source of carbohydrate. In a number of countries, especially in rural Africa, cooked bananas is a staple food, so growing these provitamin A-rich bananas will help people meet the dietary requirement.

According to James Dale, who led the research, "Achieving these scientific results is a major milestone in our quest to deliver a more nutritional diet to some of the poorest subsistence communities in Africa. We tried and tested hundreds of different genetic variations here in our lab and in field trials in Queensland until we got the best results." Although the fortified banana was developed particularly keeping the people of Uganda in mind where vitamin A-deficiency among children is as high 38 percent, it will certainly be useful also in reducing the widespread vitamin A-deficiency in other developing countries including India. ❐

Biman Basu
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Chandrayaan Data Show Moon's Interior May be 'Wet'

Till 2008, when India's first lunar probe *Chandrayaan*-1 went into orbit around Moon, the Earth's closest neighbour was believed to be bone-dry, with no trace of water. Analysis of moon rocks and lunar soil samples brought back by the Apollo astronauts did not find any evidence of presence of water in them. But *Chandrayaan*-1 changed all that. In 2009, by analysing the data collected from the lunar surface, NASA announced that the Moon Mineralogy Mapper or M3 on-board *Chandrayaan*-1 has confirmed existence of water on Moon.

The M3 instrument analysed how sunlight reflected off the lunar surface to identify water particles in which scientists observed chemical bonding similar to those found in water. However, the instrument can only see the very uppermost layers of the lunar soil – perhaps to a few centimetres below the surface. It cannot probe deeper. In 2013, NASA announced that what *Chandrayaan*-1 had detected was magmatic water, or water that originates from deep within the Moon's interior, but nothing was known about the amount of water in the moon's interior. Recent studies have shown that the Moon has as much water in its mantle as Earth's interior. Using satellite data, scientists have for the first time detected widespread water within ancient explosive volcanic deposits on the Moon, suggesting that its interior contains substantial amounts of indigenous water.

The study was done by a team from Brown University in Rhode Island, USA, led by Ralph Milliken. The researchers analysed satellite data from the Moon Mineralogy Mapper, which measured reflected sunlight at visible and near-infrared wavelengths. In order to estimate the amount of trapped water in the volcanic deposits from the *Chandrayaan* data, the scientists had to isolate the reflected sunlight from the thermal energy emitted by the Moon's hot surface. Looking at wavelengths where the molecules of water (H2O and -OH) absorb light, they found that there were larger absorptions, or less reflected sunlight, at these wavelengths for volcanic deposits, which indicates they contain -OH or H2O. The new study found that numerous volcanic deposits distributed across the surface of the Moon contain unusually high amounts of trapped water compared with surrounding terrains. The researchers said that "the finding of water in these ancient deposits, which are believed to consist of glass beads formed by the explosive eruption of magma coming from the deep lunar interior, bolsters the idea that the lunar mantle is surprisingly water-rich" (*Nature Geoscience* 24 July 2017 | doi:10.1038/ngeo2993).

Says Milliken, "Our work shows that nearly all of the large volcanic deposits also contain water; so this seems to be a common characteristic of magmas that come from the deep lunar interior. Enhanced water content associated with lunar volcanic deposits and the widespread distribution and variable chemistry of these deposits on the lunar surface are consistent with significant water in the bulk lunar

mantle. That is, most of the mantle of the Moon may be 'wet'". ❐

Biman Basu
Dream 2047, September 2017, Vol. 19, No. 12

Building Blocks of Alien Cells Discovered on Titan

Life-forming molecules have been detected within the hazy upper atmosphere of Saturn's largest moon Titan. The discovery was made by a team of scientists led by Ravi Desai of University College London (UCL) after analysing data received from the *Cassini* probe that has been observing Saturn and its moons since 2004. The scientists identified negatively charged molecules called 'carbon chain anions' in Titan's atmosphere, which are understood to be building blocks of more complex molecules, and may have acted as the basis for the earliest forms of life on Earth. The detections were made using Cassini's plasma spectrometer, called CAPS, as *Cassini* flew through Titan's upper atmosphere, 950-1,300 km above the surface (*The Astrophysical Journal*, 26 Jul 2017 | DOI: 10.3847/2041-8213/aa7851).

According to Ravi Desai, who led the UCL study, "We have made the first unambiguous identification of carbon chain anions in a planet-like atmosphere, which we believe are a vital stepping-stone in the production line of growing bigger, and more complex organic molecules, such as the moon's large haze particles".

In another significant discovery, an international team of scientists using data from the Atacama Large Millimetre/ submillimetre Array (ALMA) in Chile found molecules called vinyl cyanide on Titan that may link together to form membranes like those of living organisms on Earth. Scientists suggest this chemical composition is similar to Earth's primordial atmosphere, and the extreme cold and liquid methane on Titan could allow vinyl-cyanide molecules to link together and form sheet structures similar to lipid bilayers found in living cells on Earth – the main component of a cell's membrane.

The presence of complex molecules in Titan's atmosphere is not surprising. According to the researchers, Titan's thick nitrogen and methane atmosphere drives some of the most complex chemistry seen in the Solar System. Nitrogen and methane in Titan's upper atmosphere are exposed to energy from sunlight and energetic particles in Saturn's magnetosphere, which drive reactions involving nitrogen, hydrogen and carbon and lead to more complicated prebiotic compounds. These large molecules drift down towards the lower atmosphere, forming a thick haze of organic aerosols, and are thought to eventually reach the surface. But the process by which simple molecules in the upper atmosphere are transformed into the complex organic haze at lower altitudes is complicated and difficult to determine. This discovery adds vital information that will help scientists understand the chemical process.

The scientists believe the processes going on in Titan's atmosphere mimic the atmosphere of early Earth, before the buildup of oxygen. As such, Titan can be seen as a planet-scale laboratory that can be studied to understand the chemical reactions that may have led to life on Earth, and that could be occurring on planets around other stars. ❐

Biman Basu
Dream 2047, October 2017, Vol. 20, No. 1

Strong Adhesive for Wound Healing Synthesised

Can you stick Band Aid on wet skin or stick something with glue on a wet surface? The answer is of course, an emphatic 'No'. It is well known that to stick anything to a surface it has to be clean and dry. But now scientists have come out with a new, flexible adhesive material inspired by the glue secreted by slugs that sticks to biological tissues (even when wet) without causing toxicity. The adhesive has been developed by a team of researchers from the Wyss Institute for Biologically Inspired Engineering and the John A. Paulson School of Engineering and Applied Sciences (SEAS) at Harvard University, USA. It is a super-strong "tough adhesive" that is biocompatible

The dusky slug (Arion subfuscus), which excretes a sticky, yellow-orange slime *that adheres well to wet surfaces.*

and binds to tissues with strength comparable to the body's own resilient cartilage, even when they are wet (*Science*, 28 July 2017 | DOI: 10.1126/science.aah6362). The new glue sticks to wet surfaces, including the surface of a beating heart, and according to the scientists, since it is not toxic to cells, it has an advantage over many commercially available surgical glues.

The inspiration for the glue came from the dusky slug (*Arion subfuscus*) – a large and slimy species of slug found in North America and Western Europe. These slugs excrete a sticky, yellow-orange slime that adheres well to wet surfaces and help them cling to leaves and other surfaces. After analysing the slime secreted by the slug, the researchers found that the sticky mucus has two components: polycations that help the mucus adhere to surfaces through electrostatic interactions and covalent bonding, and a tough matrix linked by ionic bonds that absorbs and dissipates stress. This combination allows the slug to stick strongly to a surface by resisting forces – such as those from wind, rain, or the beak of a hungry bird – that could dislodge it. These "hybridised" crosslinks make the slug mucus both tough and stretchy.

To mimic this design, the researchers created a stress-dissipating matrix from cross-linked polymers, polyacrylamide, and alginate. The researchers then coated the matrix with the polycation chitosan (a linear polysaccharide made by treating the shells of shrimp and other crustaceans with an alkaline substance, like sodium hydroxide), which inserts itself into the matrix and produces an adhesive surface. The researchers tested the synthesised adhesive on a variety of both dry and wet pig tissues including skin, cartilage, heart, artery, and liver, and found that it bound to all of them with significantly greater strength than other medical adhesives. The tough adhesive also maintained its stability and bonding when implanted into rats for two weeks, or when used to seal a hole in a pig heart that was mechanically inflated and deflated and then subjected to tens of thousands of cycles of stretching. A big advantage of the new adhesive was that it caused no tissue damage or adhesions to surrounding tissues when applied to a liver haemorrhage in mice – side effects that were observed with both super glue and a commercial thrombin-based adhesive.

According to the researchers, such a high-performance material has numerous potential applications in the medical field, "either as a patch that can be cut to desired sizes and applied to tissue surfaces or as an injectable solution for deeper injuries". It can also be used to attach medical devices to their target structures, such as an actuator to support heart function. ❐

Biman Basu
Dream 2047, October 2017, Vol. 20, No. 1

Crows are Smarter than We Think

We all know that crows are clever birds. The story of a thirsty crow dropping pebbles into a jar to get water to the top for drinking is well known. A study in 2015 had shown that crows can be taught to 'count' and discriminate between groups of dots on computer screens in a similar way to humans. Other studies have shown their ability to make tools. For example a crow can bend wire to fish out or lift items from a hard-to-reach spot. Recent studies have shown that crows, or their big-size relatives, the ravens, are smarter that we take them to be. Like humans, these birds also have the ability to remember past events and use this ability to plan for the future.

One characteristic that distinguishes humans from other animals is the capacity to take decisions about future events that will unfold at other locations. This is possible because the human brain can store memories of past events to guide decision-making about current and future events. This ability allows humans to plan outside the current sensory context and covers a wide range, for example, from planning a dinner party or a vacation to making retirement plans. It was generally assumed that that animals do not use memories in this way but are mostly concerned with present needs and are unable to plan for the future. In fact, whether any other animals can plan across time has been one of the cardinal questions in animal behavioural sciences during the past decade.

A recent study with ravens (*Corvus corax*) by Can Kabadayi and Mathias Osvath of Lund University, Sweden, has shown that this notion is untenable, as carefully designed experiments have demonstrated their ability to plan for expected future events based on past experiences. The researchers tested ravens with tasks designed to specifically assess their general planning abilities. The results confirmed the birds' forwardplanning abilities, at least as well as apes and 4-year-old human children in this complex cognitive task (*Science*, 14 July 2017 | DOI: 10.1126/science.aam8138).

What is more, the study showed that ravens can anticipate the nature, time, and location of a future event based on previous experiences. According to the

researchers, this behaviour is not merely prospective, anticipating future states; rather, they flexibly apply future planning in behaviours not typically seen in the wild.

In a series of experiments, the researchers investigated whether ravens plan for the future. Each experiment included two main conditions – a technical and a social one, namely tool-use and exchanging something for food with humans. Ravens are not habitual tool users, and exchanging food for something has never been observed in the wild. Specifically, the researchers tested whether ravens can make decisions for an event 15 minutes into the future and over longer intervals of 17 hours. In addition, they also tested whether ravens can exert self-control when making decisions for the future.

The researchers presented five ravens with a choice of objects. Only one of these objects was a functional tool, which could be used to retrieve food from a puzzle box. The ravens were also trained to exchange tokens for food. The ravens chose correctly not only when they were offered the box but also when they had to store the tool and plan for the next day. One experiment investigated whether ravens could select, save, and later use either a tool or an exchangeable token that acquired functionality 15 minutes after being taken, at a different location from where it was selected. The second experiment extended the delay between item selection and use to 17 hours (overnight). Surprisingly, when the ravens knew that food would be offered only on the next day, they chose and stored these tokens as soon as they were offered to them. The results from the two experiments clearly showed that ravens take the time gap between item choice and reward into account, exercise self-control, and make decisions for predicted futures rather than arbitrary ones. ❐

Biman Basu
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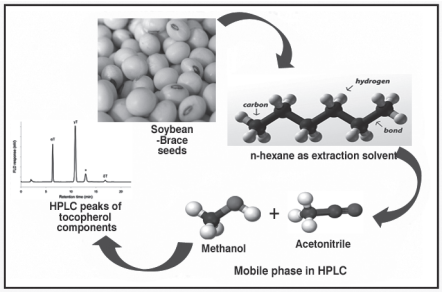
Standardization of Vitamin-E Extraction and Estimation Method

In plants, tocopherols (vitamin-E) are involved in intracellular signaling, stabilization of cell membrane and helps in improving the oil and protein quality. In humans, intake of vitamin-E leads to decreased risk for cardiovascular disease, cancer, and caducity, aids in immune function and prevents many degenerative diseases. In addi t ion to enhancing the nutritional value of crops and human health benefits, increased levels of vitamin E compounds have tremendous potential to improve the shelf life of seeds, seed vigor and seed oil quality including plant performance under stressful conditions that are linked to reactive oxygen species. The Institute's Division of Biochemistry have standardized the tocopherol extraction and estimation method in soybean (var. Bragg) seeds.



Schematic diagram showing extimation of tocopherol using HPLC

Here direct solvent extraction method was adopted using various combinations of solvents used for extraction as well as mobile phase in HPLC. Using hexane as extraction solvent and methanol: acetonitrile in the ratio of 50:50 as mobile phase solvent, highest amount of tocopherols; 83.5 ppm of total tocopherols was found as compared to the rest of the solvents and their ratios. ❐

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