VIGYAN PRASAR

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FROM COVID-19 PANDEMIC TO BILLION VACCINATIONS: 'A GLORIOUS TRIUMPH'

SRINIVASA RAMANUJAN: A GIFTED GENIUS

MODERN SCIENTIFIC THOUGHT OF ANCIENT INDIA

INTERACTIONS BETWEEN ORGANISMS

C.V. RAMAN

CELEBRATING THE NATIONAL SCIENCE DAY, 2022

Azadi Ka Amrit Mahotsav

VIGYAN PRASAR

स्वतंत्रता का अमृत महोत्सव

Editor-in-Chief
Nakul Parashar

Editor
Nimish Kapoor

Production
Pradeep Kumar
Ganesh D. Kalghuge
Bipro Kumar Sen

Language Editor
Sumita Mukherjee

Address for correspondence
Vigyan Prasar, A-50,
Institutional Area, Sector-62,
Noida-201 309, U.P., India

Tel: +91-120-2404430, 35

e-mail
dream@vigyanprasar.gov.in

website
http://www.vigyanprasar.gov.in

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Cover Design & Illustrations By: BIPRO KUMAR SEN

MY WORD

NAKUL PARASHAR

Festival of SCoPE for all

THE NATION

is celebrating the 75th year of its independence. Under the *Azadi ka Amrit Mahotsav*, several programmes are being organised all over the country in domains of culture, heritage, and many more. Science & technology are not far away from these celebrations as well. February 22–28, this year, has been set aside as the glorious yet festive week for these celebrations in the area of science & technology. This week coincides with the National Science Day (Feb 28th), when Acharya CV Raman announced the discovery of the famous Raman Effect in 1928. He was thus awarded the Nobel Prize in 1930.

This celebration has been named *Vigyan Sarvatra Pujyate*, which in Sanskrit means science is revered everywhere. It will be a festival of SCoPE (Science Communication Popularization & Extension) for all. All of this is aimed at reaching one and all through exhibitions, with theme-based daily activities–from the annals of the history of science & technology in India to the road ahead for the next 25 years. Other themes include milestones of modern Indian S&T achievements, inventions and innovations, and one full day of science literary events like theatre, poetry, and book reading. With several nationwide and local competitions lined up as a run-up to these events, these weeklong festivities would be organised at 75 locations in the country. The emphasis would be on taking festivities of science & technology to all in Indian languages for better, quicker, and meaningful impact. Thus, there will be a lot around figure 75 with 75-locations, 75-films, 75-posters, 75-books & book fairs, and a lot more. Stay tuned for more details in the coming days through the Vigyan Prasar website.

Meanwhile, Vigyan Prasar celebrated the third anniversary of its flagship project called IndiaScience, the nation's S&T channel. Currently available on the OTT platform only, this channel is absolutely free, unlike its competitors, with more than 3000 films available on it. Full of infotainment, IndiaScience.in started its journey on DTH (direct-to-home) through a slot on Doordarshan's National channel and on the OTT (over-the-top) platform on January 15th, 2019. With a vast repository of exciting content, IndiaScience is capable of turning itself into an around-the-clock DTH channel now. Interestingly, as we write, the production of popular films in a language understandable to the masses goes on unabated. So, what's holding you back from diving into the big world of IndiaScience productions! Just download the app on your handheld or Internet-connected video device and enjoy this non-stop infotainment.

For the past two years now, there hasn't been a day where we have not discussed COVID-19. Variants after variants and waves after waves, scientists continue to fight against it. Doesn't it sound wishful thinking if there could be one composite solution or vaccine that sounded like one-size-fits-all? Alas, not for the time being; thus, pushing us to remain vigilant and shun any kind of complacency. Therefore, don't crowd places and follow all those prevention protocols to save you from the increasing COVID-related complications. Once again, stay safe and be duly protected, something like a pearl in a sea-shell.

Email: nakul.parashar@vigyanprasar.gov.in

AJAI CHAWLA

C.V. RAMAN

CELEBRATING THE NATIONAL SCIENCE DAY, 2022

The National Science Day 2022 is going to be extremely special as we are celebrating 75 years of India's independence.

"A glass of water does not have any colour of its own. But the same water in the deep sea appears a brilliant blue. Why is this so?"

If this was a question that had been asked anyone before 1928, the obvious answer would have been that it is so because the sea reflects the colour of the sky. In fact, this was the theory that the scientists of that period also believed in. But the Indian scientist Chandrasekhar Venkata Raman considered this as too simplistic an explanation.

As the story goes, Sir C.V. Raman, a professor at University of Calcutta, was invited in 1921 as a delegate to the International Universities Congress in London. While on board the ship SS Narkunda on his return journey to India, he was fascinated with the deep blue colour of the Mediterranean Sea. It struck him rather odd that the sea water maybe appearing blue because it reflects the colour of the sky.

He firmly believed in the dictum that 'If one asks the right questions, nature will open the doors to her secrets' and this was the time to put it into practice. He conducted basic experiments on the ship itself, with the simple instruments that he was carrying with him, striving to unravel a solution to this problem. Through these initial experiments he found that even though the sea looked blue for quite the same reason that the sky looks blue, it was more likely that the water was causing blue light to scatter more than other colours in the light. This realization excited him and as soon as he was back home, he wrote a paper on the subject to Nature, a science journal.

As the years rolled by, he delved deeper into the 'scattering question' as he liked to call it. He conducted a series of experimental observations involving passing of light through a variety of substances. During one such experiment, his student K.S. Krishnan observed a greenish glow in glycerine. On the historic day of 28th February, 1928, Raman conducted further investigations and confirmed the presence of 'induced secondary radiation', implying that the light of only one colour was being passed through the liquid, but the light that was emerging had traces of another colour. Simply put, this implied that molecules in the liquid were changing the colour of some of the light passing through it. The journey up to this firm conclusion had been quite tedious, especially with the limited means that he had at his disposal under the British rule, but eventually his efforts paid off with the discovery of the 'Raman Effect'. This discovery created quite a sensation across the world, and while Raman earned a Nobel Prize for it in 1930, it also propelled India on the global 'Science map'. Later in the century, in 1986, when the Department of Science and Technology proposed to the Government of India to celebrate National Science Day in the country, the obvious choice for the designated day was 28th February, the day that represented not only the genius of Sir C.V. Raman but also the day when the capabilities of the scientific minds in India was glorified.

The first National Science Day was celebrated on 28 February 1987. The vision for the observation of National Science Day is to spread messages among the masses of the importance of science and its applications in daily life. As such, this day is celebrated in a festival mode to showcase all the activities, efforts, and achievements in the field of science for welfare of human beings particularly in the domain of disease eradication, energy production, environmental issues, information technology, space exploration etc. Discussions are undertaken on all the science-related issues involved and for implementing new technologies for the development of science. An opportunity to the scientific-minded citizens in the country is offered through various interactive sessions, workshops, and seminars, and various activities are organised to popularise and encourage participation in Science and Technology. It gives space for exchange of thoughts on reasoning and experimental observation to facilitate mental and intellectual excellence among the scientific community. On National Science Day, the impact of biotechnology on agriculture, environment, health, industry, and pharmaceuticals is emphasized. The day also lists the initiatives taken by the scientific community to disseminate specific knowledge to the future generations. And lastly but not the least it aims to inculcate scientific temper among the children and youth of today.

The National Science Day, 2022 is likely to hold a special place in the annals of Indian history, as it is being held during the year-long celebrations marking 75 years of India's independence. The idea behind the chosen theme for this year-'Integrated Approach in S&T for Sustainable Future' is

to adopt a four-fold approach namely integration of all the scientific departments that can work on theme-based approach; extended scientific integration encompassing engineering, medical, and other institutions; extra scientific integration involving identification of the needs of other ministries like water, energy, railways etc.; and extended science-driven all-inclusive approach integrating start-ups & industry. As Dr Jitendra Singh, the Union Minister of State for Science and Technology (S&T) puts it, "This will help us come out of our culture of working in silos as suggested by the Hon'ble Prime Minister, to play a leading role in the global arena This is the best time to give a push to this integrative approach as all the ministries and departments have come together to work for the survival of humanity at the time of the pandemic crisis."

Department of Science and Technology (DST) acts as a nodal agency to support, catalyse, and coordinate celebration

of the National Science Day pan India in scientific institutions, research laboratories and autonomous institutions associated with it. On this day DST also supports various programmes by giving grants to its State S&T Councils & Departments for organization of lectures, quizzes, open houses, and theme-based science communication activities in schools, colleges, and universities. Many institutions organize an open house for their laboratories to appraise students about career opportunities available in a particular research laboratory or institution. Many activities are also related to science communication across disciplines, as it forms a crucial part of the new science and innovation policy. Usually every year more than 600 science projects are demonstrated by school and college students while National and State science institutes and universities showcase their latest research. There are public talks, science movie screenings, night sky observing, live demonstrations, and many more.

Following the first NSD in 28 February 1987, the National Council for Science and Technology Communication (NCSTC) announced the creation of the National Science Popularization awards to recognise individuals for their contributions in the realm of science and its communication as well as to inculcate scientific temper among masses. These awards are presented every year on National Science Day along with the Rajendra Prabhu Memorial Appreciation Shield and Women Excellence Award by the Science and Engineering Research Board (SERB), a statutory body of the DST, supporting basic research in frontier areas of science and engineering. It provides grants to women scientists below 40 years of age who have received recognition from any one or more of the National Academies such as Young Scientist Medal, Young Associateship and so on. Augmenting Writing Skills for Articulating Research (AWSAR) award is presented on the day, which is an initiative of DST, Government of India to recognize the dissemination of Indian research in Science, Technology & Innovation being pursued by PhD Scholars and Post-Doctoral Fellows in popular science writing.

In times to come as per the vision of the Government of India, the scope of the National Science Day will no longer be limited to a one-day event as it is felt that there is a need to build upon the theme of the year on a regular and holistic basis.

MILESTONES OF NATIONAL SCIENCE DAY

Since 1999, the National Science Day has been celebrated with certain specific themes as the core.

YEAR	CHOSEN THEME
1999	Our Changing Earth
2000	Recreating Interest in Basic Science
2001	Information Technology for Science Education
2002	Wealth from Waste
2003	50 years of DNA & 25 years of IVF–The Blueprint of Life
2004	Encouraging Scientific Awareness in Community
2005	Celebrating Physics
2006	Nurture Nature for our future
2007	More Crop Per Drop
2008	Understanding the Planet Earth
2009	Expanding Horizons of Science
2010	Gender Equity, Science & Technology for Sustainable Development
2011	Chemistry in Daily Life
2012	Clean Energy Options and Nuclear Safety
2013	Genetically Modified Crops and Food Security
2014	Fostering Scientific Temper
2015	Science for Nation Building
2016	Scientific Issues for Development of the Nation
2017	Science and Technology for Specially Abled Persons
2018	Science and Technology for a sustainable future
2019	Science for the People, and the People for Science
2020	Women in Science
2021	Future of STI: Impact on Education Skills and Work
2022	Integrated Approach in S&T for Sustainable Future

The author is a science communicator and filmmaker.
Email: ajai_c@yahoo.com

KINKINI DASGUPTA MISRA

"VIGYAN SARVATRA PUJYATE": Witness the captivating saga of India's Incredible STI Journey

We find reasons to celebrate and the importance of science in our lives is one of the most significant among these. For our destiny and that of the nation is entwined with science, technology, and innovation. A nation's progress cannot be seen in isolation to the advancements it makes in the field of science. Both are inalienable, rather directly proportional. As the nation commemorates *Azadi Ka Amrit Mahotsav*, marking the 75 glorious years of its Independence with pomp and gaiety, India's prowess in the field of science needs to be showcased and popularised in vernacular languages for orienting people towards STI, making them understand and witness the incredible journey of the Indian STI and for the common good. Vigyan Prasar, since its inception, has been working in this letter and spirit and for the furtherance of this objective, it plans to hold a mega event *"Vigyan Sarvatra Pujyate"* or Festival of SCoPE (Science Communication, popularisation and its Extension) on the occasion of Science Week (21-28 February). The pan India event is slated to kick-start with a grand inaugural on 21 February and would be held at 75 locations across the country.

Organized under the aegis of the Office of PSA and in association with as many as 18 Government Ministries the event would be marked by poster-making competitions, radio talks, science lit Fest, mega exposition, lectures and several other activities. There would be 75 lectures by eminent experts from every S&T-related Ministry, 7-day long expositions at 75 locations, 75 lectures by eminent experts from the Indian Diaspora, 15 national competitions for school and college students, 75 curtain-raiser programmes at 75 locations, and much more.

Each day will be special in the sense that it will reflect or portray some aspect of science, technology, and innovation and its importance in the lives of the citizens. Be it traversing down the lane to witness the annals of scientific history on Day-2 or cherishing the 75 milestones from the world of Indian Science & Technology on Day-3, showcasing indigenous, traditional science & technology (*Swadeshi-Paramparik Vigyan evam Praudyogiki*) on Day-4 (75 traditional knowledge gems of Indian S&T, 75 Inventions/Innovations and Start-ups); the Film and Literature Festival on Day-5, or envisioning the future roadmap of Indian S&T for next 25 years on Day-6, we believe each event would be engaging, captivating, and enticing for the scientists and the commoners alike besides being a unique learning experience for all of us. The week-long programme would conclude on Day-7, 28 February coinciding with National Science Day at Vigyan Bhawan. The National Science Day event would be marked by felicitation, award distribution, book releases, and much more. The Indian STI has travelled a long way since independence and is playing a pivotal role in the nation's progress. Science serves good to humanity, while science communication plays an important role in making science reach people so that they can reap its benefits.

Let's celebrate this spirit and be partners with India's incredible STI journey at *"Vigyan Sarvatra Pujyate"* with heads held high and feet firmly planted on the ground—the firm ground that the STI has laid for us

The author is Scientist F in Vigyan Prasar.
Email: kdgm@vigyanprasar.gov.in

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N.K. PRASANNA AND S.K. VARSHNEY

FROM COVID-19 PANDEMIC TO BILLION VACCINATIONS:

'A Glorious Triumph'

We have ushered in another new year in the middle of the COVID-19 pandemic and with the panic of a new variant, Omicron. Many unforeseen and unexpected developments happened in the country in developing the COVID-19 vaccines and their distribution. At the beginning of the year 2021 the fear of the pandemic triggered stresses and frightened the entire country. However, the 'billion vaccine' achievement of India has not only built confidence among the Indians but also has brought international accolade. Let us recall the key developments and have a look at what has taken place in India in 2021 with respect to Coronavirus.

World's largest vaccination drive

In 2021, detailed vaccine distribution plan was implemented in order to protect the public from the worst ravages of the corona outbreak. Emergency approvals were issued for the indigenous vaccines Covaxin and Covishield. The vaccines were available from 16 January 2021. In the first phase, it was administered to the healthcare workers and frontline workers. After that, the vaccination was extended in a phased and scheduled manner to the general public.

Delta variant

Just as India was recovering from the horrors of the first wave, the second wave hit India in April 2021. It was attributed to the delta variant of SARS-CoV-2. Maharashtra was the first state to report this variant. It was found to be more lethal and capable of generating more severe symptoms, resulting in a higher rate of patient hospitalisation. India was the second-worst affected country (in terms of total number of cases).

B.1.617.2 (Delta) has been followed and monitored all around the world. Due to its enhanced transmissibility, WHO has called it a variant of concern (VOC). The Delta variant spreads quickly and dangerously among people crossing the borders across the countries and expected to expand its geographical scope further. A variety of reasons are contributed to the growing propagation of the virus across the world. With more social mixing, increased mobility, relaxation or improper use of public health and social measures are a few reasons that can be attributed to its propagation. The existence of large numbers of unvaccinated persons is also posing a danger.

Delta Plus Variant

The COVID-19 Delta Plus Variant is a mutated form, i.e., sub-lineage of the delta variant that was first detected in India, which too was sequenced in Maharashtra. Containing mutations of two COVID variants-the Beta variant (discovered in South Africa) and the Delta variant (discovered in India), the Delta Plus contains two striking mutations-L452R and P871R, having symptoms such as increased infection, strong binding to receptors in lung cells, and greater resistance to monoclonal antibody treatments.

Both the Delta and Delta Plus variants have been categorized as VOC and have spread in many countries, especially where vaccination coverage is on the lower side.

Not only were maximum cases found to be genomically traced to this variant of the virus, it still remains to be a concerning variant adding cases, even after the decline of the second wave trajectory in India. In states still recording worrying caseloads, the Delta variant has been deemed responsible. Symptoms include early-stage lung involvement, shortness of breath and breathing difficulties, prolonged fever, and persistent cough. Gastrointestinal symptoms, skin rashes and allergies, dryness and watery eyes, appetite loss and nausea are some other common symptoms.

Second wave and Oxygen crises

India could cope with the first wave with its limited health infrastructure and invested a lot in R&D to develop diagnostic kits, therapeutics/

repurposed drugs, and vaccines in its fight against SARS-CoV-2. India could start its vaccine programme on 16 January 2021. It also donated lakhs of doses to its neighbouring countries as goodwill gesture and vaccine diplomacy. This set an example to show 'vaccine liberalism' while the rest of the World was adamant on 'vaccine nationalism'.

However, this didn't last long as the second wave caught India unaware, which created a sudden increased demand for vaccine, Oxygen, hospital beds, and timely diagnosis and suitable treatment against mucormycosis and SARS-CoV-2. The country experienced a humanitarian crisis during the second wave. It was a dreadful example of a population that was yet to achieve COVID-19 herd immunity. There were several accounts of hospitalized patients running out of oxygen and bodies being burnt on pyres in the streets, which indicated a failing health system. In some hospitals, two or three patients had to be treated on a single bed with one oxygen cylinder with limited ventilators. Demand for portable oxygen concentrator also grew tremendously.

Oxygen express

To meet up the demand for Oxygen, Indian Railways decided to run Oxygen Expresses. It started on 24 April 2021 to provide respite to Indian states requiring medical Oxygen. More than 35000 MT of LMO (Liquid medical oxygen) was transported to 15 states. Around 480 Oxygen Expresses were operationalized during that time.

Billion record in vaccination mark

In the middle of many dos and don'ts, India has written a new chapter in COVID-19 vaccine distribution. Our vaccination drive that started on 16 January 2021 touched a major milestone on the 279th day by crossing the billion dose mark on 21 October. As of 4 January 2022, it stands at 146 crore doses covering, 44.1% of the population.

EMERGENCY APPROVAL FOR TWO MORE VACCINES

India has approved two vaccines Carbivax and Kovovax and one antiviral drug Molnupiravir under emergency use. The expert committee of the Central Drug Standards Authority (CDSCO) has given these approvals.

Carbivax: This vaccine was developed by Hyderabad-based company Biological-E. It contains the receptor binding domain (RBD) version of the spike protein, the SARS-CoV-2 virus that causes COVID-19. It should be taken in two doses. It was developed with the same technology as the Hepatitis-B vaccine.

Kovovax: Developed by Novavax, US and manufactured by the Serum Institute of India this vaccine, which contains purified components of the virus, helps to enhance immunity.

Molunpiravir: It is an antiviral drug manufactured by the American company Merck and Ridgeback. Initially, it was to be provided under emergency use to those at high risk of COVID-19 infection. However, it has been now declared out and not recommended by Indian Council of Medical Research (ICMR) for major 'safety concerns'.

India is moving ahead with strategies to counter COVID-19 effectively. So far a total of 8 vaccines and 4 treatments have been approved.

Covishield: A serum developed by Astrazeneca in collaboration with the University of Oxford is developed by Serum Institute of India. This vaccine works by targeting the spike protein.

Covaxin: It is an indigenous vaccine developed by Bharat Biotech, a Hyderabad-based company. The vaccine was developed by ICMR in collaboration with NIV using an inactivated virus.

Sputnik-V: The vaccine was developed by the Gamalea Research Institute in Russia. It was developed with a combination of two adenoviruses Ad5 and Ad26.

Zykov-D: This DNA-based vaccine has been developed by Zydus Cadila from Ahmadabad. The vaccine should be taken in three doses. The vaccine is given with a special applicator that does not require a syringe. The blueprint gene that modifies the virus genome is injected into the body in the form of a vaccine.

Moderna: The two-dose vaccine was developed by the American company Moderna with the help mRNA genetic code. This viral protein trains to develop the immunity.

REGEN-COV2 Antibody Cocktail: This cocktail offers antibody treatment with a combination of Casirivimab and Imdevimab monoclonal antibodies. It is especially given to COVID victims who have mild to moderate symptoms.

Johnson & Johnson: It was developed by Johnson and Johnson, an American company. It is a single-dose vaccine made with an adenovirus vector.

Tosilizumab: This medicine is manufactured by Roche in Switzerland. Cipla will import this drug and supply in India. This drug is for patients with rheumatoid arthritis and issued to treat lung infections in COVID-19patients.

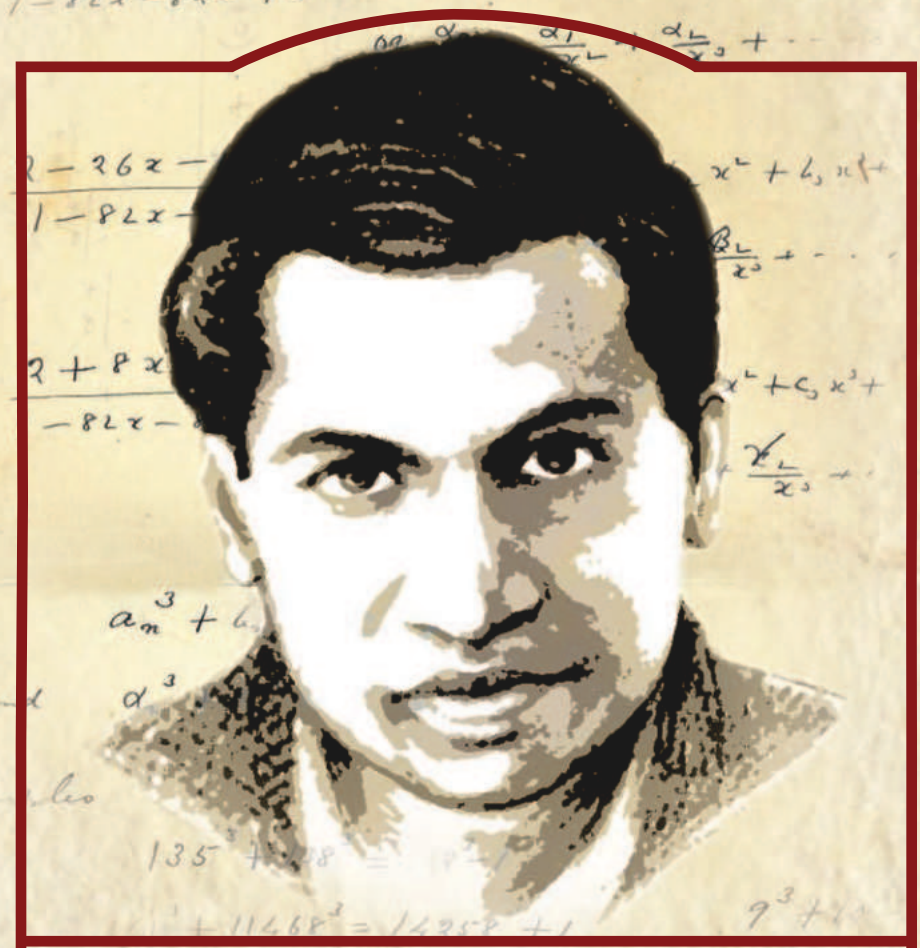
2-DG (2-deoxy-D-glucose): This drug was developed by Dr Reddy's Lab in collaboration with DRDO. It should be taken orally. The glycolysis method inhibits the virus growth.

Emergence of new variants

When the Indian populations are braving the pandemic by following the restrictions and COVID protocols, another wave in the form of Omicron is hitting India, the USA and several European countries. Our Hon'ble Prime Minister Narendra Modi has urged all population and state administrations to take proactive measures to prevent the spread of infection.

N.K. Prasanna is a Scientist at CSIR-National Institute of Science Communication and Policy Research (CSIR-NIScPR), New Delhi. S.K. Varshney is Head, International Cooperation, Department of Science and Technology, New Delhi.
Email: prasanna@niscair.res.in; skvdst@nic.in

SHIVAPRASAD KHENED



SRINIVASA RAMANUJAN: A Gifted Genius

India celebrates 22nd December, the birthday of the legendary mathematician Srinivasa Ramanujan as the National Mathematics day. He was born on 22 December 1887, in Erode, Tamil Nadu. In his short life (1887-1920) he left behind a legacy, which has been motivating people from all over the world. C.P. Snow, friend of G.H. Hardy who was the mentor of Ramanujan, wrote in the preface to Hardy's remarkable memoir, 'A Mathematician's Apology', 'Hardy did not forget that he was in the presence of a genius-Ramanujan'. Hardy, considered one of the leading mathematicians of the world, had profound respect for Ramanujan's genius in mathematics. It is evidenced in another incident that Hardy narrated to his friend, Snow. Hardy says, 'Ramanujan really had the natural genius. in the sense that the greatest mathematicians had it'. Hardy, on another occasion modestly says, 'I have done one thing that most others could never have done, and that is to have collaborated with the greats like Ramanujan on something like equal terms'.

Our admiration for Ramanujan grew exponentially while researching for curation and development of an exhibition on his life and works during his 125th birth anniversary in 2012. The then Prime Minister of India, Shri Manmohan Singh, declared that the birthday of Ramanujan will be celebrated and commemorated as the National Mathematics Day, and ever since 22nd December is celebrated as the National Mathematics Day.

The first thing that came to our mind when developing an exhibition on Ramanujan was the well-researched biography on Ramanujan, written by Robert Kanigel entitled "The Man Who Knew Infinity: A Life of the Genius Ramanujan". During the early days of discussion on the curatorial concept and the approach that we should adopt for developing this exhibition was to ensure that the subject mathematics, which is considered abstract and hard to comprehend, must be made simple, experiential, and interactive. We also felt that the most apt title for our exhibition would be the title of the book-The Man Who Knew Infinity: A Life of the Genius Ramanujan. We therefore sought permission from Dr Kanigel, who was very kind to permit us to use this title for our exhibition. We worked on a different presentation style for the exhibition and for the first time attempted some new digital interactive techniques to present the complex math that Ramanujan carried out in a manner which could be appreciated by our visitors, particularly school students. This exhibition was successfully opened in December 2012 by Padma Bhushan Prof. M.S. Narasimhan, FRS and a member of the National Committee for National Mathematics Year, at Visvesvaraya Industrial and Technological Museum, Bangalore.

The exhibition received overwhelming response and appreciation, particularly the digital immersive experience and interactive presentations to present the life and works of the legend. The exhibition also had a lesson for our youngsters that failure is something which has not spared even the great Ramanujan, and therefore students must not be afraid of failures. In his authoritative biography of Ramanujan, Kanigel states that 'Ramanujan appeared for the Intermediate examinations four times and failed in all of them'. "Except for maths he did poorly in all

his subjects. ... He would take the three-hour maths exam and finish it in thirty minutes." T.V. Rangaswami's Tamil biography ('Ragami') on which Kanigel's account of Ramanujan's early life is largely based, states that 'Ramanujan appeared for the F.A. examination three times and failed'. Ragami, however, adds that in his last attempt, in 1907, Ramanujan got a centum in mathematics. David Leavitt in his book 'The Indian Clerk (2007)' underlines the repeated failures of Ramanujan in his intermediate examinations, a point reiterated by the Ramanujan Museum's website: "Appeared privately for F.A. examination, secured centum in mathematics, but failed to secure pass marks in other subjects." Our exhibition effectively communicated a lesson from Ramanujan's life that failures are integral to one's life and that includes some of the greatest of scientists as well.

Notwithstanding his multiple failures in intermediate exam one thing remained certain for Ramanujan. His love and passion for maths never attenuated; rather he pursued his passion for maths with much more focus and managed to publish quite a few papers in leading mathematical journals of India before managing to earn a job as a Clark in the Madras Port Trust. It was here that Ramanujan wrote that famous letter to his mentor, G.H. Hardy in the year 1913, and the rest what they say is now history. The letter of Ramanujan, though it evoked mixed response from Hardy initially, befittingly earned Ramanujan an invitation from Hardy to the Trinity College, Cambridge. In just five years of his stay there, Ramanujan, with mentoring from Hardy for being more structured in his approach to solving mathematical problems, made profound contributions in mathematics and that too during the most testing times of the World War I. Befittingly, his outstanding contributions at the Cambridge University won Ramanujan the B.A. degree 'by research' in 1916. This was a momentous occasion for Ramanujan who had no formal college degree until then. This was the first of many great recognitions and honours, which were destined to follow Ramanujan in the years ahead at England and in India. The Trinity College, London and also the Royal Society conferred their prestigious fellowship on Ramanujan. Incidentally, Ramanujan became the first Indian to be so honoured with the fellowship of the Trinity College when he was only thirty.

> *"Ramanujan was a unique genius of great power and keen insight. His work is of continuing importance. It has affected the advanced studies in modular forms; indeed P.Delign's Field's Medal was awarded for his proof of the Ramanujan Tau Conjecture."*
>
> George Andrews

> *"...he (Ramanujan) combined a power of generalization, a feeling for form, a capacity for rapid modification of his hypotheses, that were often startling, and made him, in his peculiar field, without a rival in his day."*
>
> G.H. Hardy

The legend of Ramanujan is now known to almost every household in India, and most students in the country will certainly have heard his name, though not quite familiar with his works. Notwithstanding the inspiration that Ramanujan provided for our youngsters, most unfortunately maths has been overly segmented as a subject meant only for the so-called intellectuals, distancing it from common folks. Declaration of the National Mathematics Day had improved this scenario in India to some extent. Mathematics is one of

the most important subjects, which acts as a tool to solve problems of every other science subjects. It provides students an opportunity to think in her own way and seek solutions to the problems. It makes a student systematic and methodical and encourages them to make their lives orderly. It is perhaps for this reason that Mathematics is often called the mother of all sciences and it is befitting that the birthday of Ramanujan, the greatest of mathematicians of India, is celebrated as the National Mathematics Day in India.

Ramanujan was a non-traditional mathematician who has been befittingly hailed as an all-time great mathematician of India in modern times and is famously clubbed with the other international greats like Euler. It is quite well known that Hardy was a diehard cricket fan and used cricketing parlance in every field, including in rating scientists and mathematicians in a scale he termed 'Bradman Scale'. He included the likes of the great mathematician Euler and Newton in the highest scale - the Bradman scale. What his rating for Ramanujan would have been can best be seen in the quote of another mathematician, Bruce C Berndt, who says, "Paul Erdos has passed on to us, Hardy's personal ratings of mathematicians. Suppose that we rate mathematicians on the basis of pure talent on a scale from 0 to 100, Hardy gave himself a score of 25, Littlewood 30, Hilbert 80 and Ramanujan 100'. It is so heartening to see that Hardy, who is credited to be the discoverer of Ramanujan, has rated his prodigy far higher than himself and his close associate Littlewood, another great mathematician of their time."

Although Ramanujan lived only for 32 years (22 December 1887–26 April 1920), out of which he spent just five years in the company of Hardy and Littlewood in Cambridge, he had left behind a very large volume (4000 original theorems) of his works (including the famous works rediscovered in his 'lost notebooks'), which continue to fascinate the greatest of mathematicians of the world even today. Legend has it that Srinivasa Ramanujan's mathematical genius came from goddess Namagiri - his family deity in Kumbakonam-in whose reverence Ramanujan had undying faith. It is often said that Ramanujan credited his ideas and solutions to Namagiri, who helped him decipher mathematical theorems in his dreams. An anecdotal story associated with the number 1729 is quite well known. Hardy, in his memoir, says that he once went to see Ramanujan who was ill and lying in the hospital bed in Putney. Hardy rode to the hospital in a taxi with 'dull and unimpressive number 1729', and he hoped that it was no bad omen number for him. When

This famous photo is prepared from the negative of his passport photo while he returned from England in 1919.

Ramanujan with his friends in Trinity

Ramanujan in Cambridge

Hardy informed Ramanujan of this 'unimpressive number', Ramanujan turned around to say that it was not a dull number, rather it is a very interesting and quite a unique number. He told Hardy that 1729 is the smallest number expressible as sum of two cubes in two different ways: 1729 = $12^3 + 1^3 = 10^3 + 9^3$. Because of this incident, 1729 is now known as the Ramanujan-Hardy number. Littlewood, an associate of Hardy, who also collaborated and worked with Ramanujan, once said, 'Ramanujan could remember the idiosyncrasies of numbers in an uncanny way' ... 'courtesy Namagiri Goddess' and for Ramanujan every positive integer was one of his personal friend'.

Srinivasa Ramanujan was born to a poor orthodox Tamil Brahmin family on 22 December, 1887 in his grandmother's house in Erode, Tamil Nadu. His father, Kuppuswamy Srinivasa Iyengar, worked as a clerk in a sari shop in Kumbakonam and his mother, Komalatammal, was a housewife who sang devotional songs at a local temple. They lived in a small traditional home on Sarangapani Sannidhi Street in the town of Kumbakonam. When Ramanujan was just 2 years old, he contracted smallpox, whose marks were conspicuous during his childhood days. Ramanujan confronted a life of extreme poverty during his younger years. His early studies were in different schools in Kumbakonam from the age of five until entering the Town High School at the age of 11. From his childhood, Ramanujan had a great passion for mathematics. So much so that at the age of 12 he had mastered trigonometry (SL Loney: Plane Trigonometry) and developed many theorems on his own with no assistance. Ramanujan was a precocious child and did very well in school and hardly evinced any interest in any other activities or games other than his studies in maths. While his friends played, Ramanujan engaged himself in nothing but academics. The first sign of his extraordinary talent in maths was noticed when he was 13. He also started working on his own on summing geometric and arithmetic series, far beyond his class. He engaged himself in solving cubic and other fairly complicated problems, some of which he failed. He would engage his teachers in some unorthodox questions. He once questioned a teacher, who was teaching the class that any number divided by that number equals one. He asked him whether zero divided by zero would be one.

A major turning point in the life of Ramanujan came when he came across a mathematics book by G S Carr called 'Synopsis of elementary results in pure mathematics'. This book was a compilation of thousands of mathematical results, with most of the results not explained properly with adequate proof. This book was written as an aid to coaching mathematics students facing the notoriously difficult Tripos examination, which involved a great deal of rote memorization. However, this book greatly influenced Ramanujan and it inspired him to pursue his passion in maths with vigour and at a feverish pace. He worked through the book's results and beyond at the cost of other subjects. The style and approach of Carr to write the equations and solutions without giving mandated proof for the problems and equations became a trade mark of Ramanujan, who had fallen in love with this book. He worked extensively on his slate trying to find solutions to the problems. It must be remembered that working on slate was a necessity for him since he could not have afforded pen and paper, which is one reason why we don't know what went into the mind of Ramanujan while solving problems.


Triplicane

From
S. Ramanujan
7 Summer House
Triplicane

To
The Chief Accountant
Port Trust
Madras

Sir,

I beg to remain,
Sir,
your most obedient servant
S. Ramanujan

Mathematical Genius Ramanujan's application in his own handwriting for a post in Madras Port Trust

In 1904, Ramanujan joined Government Arts College in Kumbkonam. Unfortunately, by now he was completely engrossed in maths with Carr Synopsis, which left him with no time for other subjects. The outcome was on expected lines. He failed in all the subjects in college except excelling in maths. The failure did not help his cause and he had to lose the much needed scholarship that he received while joining the college. Failure played on his mind and he ran away from home to Andhra Pradesh. On his return he enrolled at Pachaiyappa's College in Chennai. Here, too, he engaged himself mostly in maths and couldn't comprehend subjects like physiology and once again failed in the BA Fine Arts exam. He had no way but to leave the college, without attaining a degree. Failure in BA did not however deter him from continuing his independent research in maths.

(*To be continued*)

The author is Former Director,
Nehru Science Centre, Mumbai.
Email: dirnscm@gmail.com

SATYABRATA PANIGRAHY

Modern Scientific Thoughts of Ancient India

The ancient knowledge available at the time of Vedic civilization and other Eastern philosophies of India are well known. An important hymn of Rigveda, 'Nasadiya sukta', describes the creation theory. It says reality or source of the Universe is one and only one. Before the manifestation of the Universe, there was neither 'non-existence' nor any 'manifested' things. There was neither space nor any particles. There was neither mortality nor immortality; neither day nor night. There was no *prana* (force). It existed with its *Maya* or *Prakriti* (unmanifested energy) as a single entity. Apart from this non-dual one, there was nothing else whatsoever. In the beginning, it originated from *Maya* (increase of entropy) in a superheated condition (*tapasa*). The Universe started with an explosion and expanded below and above like a flash of the Sun's rays.

The Vedic theory of origin of the Universe is explained by 'Purusha sukta' and '*Hiranyagarbha sukta*'. Hiranyagarbha or the golden cosmic egg is said to be the source of all matter (*Akasha*) and force (*Prana*). The Universe was created with the explosion of the Hiranyagarbha. Chandogya Upanishad also says that the Universe came into exist after the explosion of the cosmic egg. According to the modern scientific theory, the creation started from the 'Big-Bang', the great explosion. Rigveda describes that the basis of creation of the world is 'sacrifice' (*Yajna*). The primordial furnace of the newly born Universe has been compared to a sacrificial action. Creation has been called as the '*Asvamedha Yajna*' (sacrifice of energy). 'Asva' here means energy or the ability to do work and 'medha' means to sacrifice. Therefore, sacrifice of energy in a superheated condition was needed for the big-bang explosion at the beginning of the Universe.

According to *'Shiva'* and *'Shakti'* tradition of Indian culture, there was infinite silence all around before the creation of the Universe. There was no 'time', because Shiva was a state and not under any time like past, present, or future. Shiva is 'Mahakala', which means time cannot influence him; he is beyond space-time-causation. Time has a beginning as defined by Physics. With Shiva's *'Tandava'* dance, with the vibration, that the state of silence became dynamic. That vibration is called *'Spanda'* or *'Shakti'* in Shaivism. The frequency with which it vibrated is the frequency of the cosmic sound 'Aum'. Thereafter, 'shakti' (Quanta of energy) emerged from Shiva, and consequently, this whole universe came into existence. The Nataraja figure of Shiva explains this phenomenon. Carl Sagan and Fritjof Capra drew the metaphor between the cosmic 'tandava' dance of Shiva and the modern study of cosmic dance of subatomic particles in vacuum fluctuation. The vacuum state looks like empty and silent, though it contains energy. That vacuum space is Shiva and the dynamic energy associated with vacuum is Shakti. On 18 June 2004, CERN (Council for Nuclear and Particle Physics Research) unveiled 2-m-tall

statue of the Lord Shiva, which was a gift from India. It represents the metaphor that was drawn between the cosmic dance of the Nataraj and the modern study of the 'cosmic dance' of subatomic particles. Physicist Fritjof Capra has explained in his book titled The Tao of Physics, "The Dance of Shiva symbolises the basis of all existence. At the same time, Shiva reminds us that the manifold forms in the world are not fundamental, but illusory and ever-changing. Modern physics has shown that the rhythm of creation and destruction is not only manifest in the turn of the seasons and in the birth and death of all living creatures, but is also the very essence of inorganic matter."

Ancient Indian sage Kanada was the founder of 'Vaishesika Sutra'. The *Vaishesika* philosophy represents atomistic pluralism. The Vaishesika divides all existent reals into two classes: Bhava or being and *Abhaba* or non-being. A category is called as 'Padartha'. Seven Padarthas identified by Vaishesika are Substance (*dravya*); Quality (*Guna*); Action (*karma*); Generality (samanya); Particularity (*vishesha*); Inherence (*samavaya*); and Non-being (*abhava*). The nine substances are earth (*Prithvi*); water (*Apah*); fire (*Tejas*); air (*vayu*); ether (*akasha*); time (*kala*); space (*dik*); spirit (*atman*); and mind or internal organ (*manas*). Vaishesika philosophy probably was the first to present the atomic concept. It states that the minutest particle of matter is called an atom (*paramanu*) which is indivisible, eternal particles. All physical things are produced by the combinations of atoms. The atoms are said to be of four kinds: earth, water, fire, and air. Ether is not atomic. The atoms differ from one another in both quantity and quality. A dyad (*dvyanuka*) is minute (*anu*),short (*hrasva*) and imperceptible. Three dyads form a triad (*tryanuka*) which is great (*mahat*), long (*dirgha*), and perceptible.

The statue of Nataraja at CERN

Physicists often search for a theory, which will explain the laws of nature. Vedanta, which is considered the most advanced form of scientific and theological treatise of cultural heritage of India, says, the whole Universe emerged from the absolute non-dual reality 'Brahman' through its power, 'Maya'. Maya is the power of Brahman to spread energy and dynamism and to make various appearances from a single source. Vedanta says the Universe is constituted from 'Nada-brahman'. 'Nada' in Sanskrit means sound or vibrations. As per the String theory everything in the Universe, every particle of light and matter, is comprised of miniscule vibrating strings; and mass, charge, and other properties are determined by the vibrational modes of the string. This Universe is not random or accidental. Without a conscious agent this intelligent design of the Universe is impossible. The unique values of the physical constants of the Universe have a great importance and many prominent scientists and scholars feel that there might be some purpose for the Universe (fine-tuning). The creation theory of *Advaita Vedanta* rejects any type of creation ex-nihilo. Chance phenomena are not ignored in Vedantic evolution. When the Nobel laureate physicist Roger Penrose gave his concept of cyclic universe, according to which Big Bang was not the start of our Universe, rather it was the end of the previous one, it reminds us of the shloka in Bhagvad Gita, where Krishna says to Arjun, in the beginning of time through Maya he created everything and at the end of time the whole universe will merge in Maya. In this process the whole Universe is created and annihilated again and again in a cyclic process. The aim of ancient thoughts is to find the ultimate reality, though the paths taken may be different.

The author is pursuing M.Sc. in Physics at Siksha O Anusandhan University, Bhubaneswar.
Email: satya1999situ@gmail.com

AMRITA SINGH

Interactions between Organisms

Although seemingly calm, ecosystems can be as busy as a city during rush hour. The soil of a forest ecosystem teems with bacteria, fungi, nematodes, springtails, amoebas, mites, slugs, worms, beetles, spiders, and scores of other organisms that churn the ground as they move about, grow, and reproduce. Interdependencies between animals, between plants, as well as between plants and animals can be seen in nature. Interactions are found among them in various gradations, from being for whole life to casual and temporary.

Positive interactions

Here populations help one another in respect of food, shelter, substratum or transport in which either one or both the species are benefited. Both partners may be in close contact or one of them may live within a specific area of the other or attached to its surface. These beneficial interactions are divided into the following:

1. Mutualism

Mutually beneficial interspecific interactions are more common in the tropics. In such association, the mutualistic interaction is essential to the survival or reproduction of both participants. The two populations enter into some sort of physiological exchange. Because many mutualistic interactions are symbiotic, it is sometimes called 'obligate symbiosis'. The pollination of some flowers by specific insects, birds, or bats and the interaction between ants and the *Acacia* plant in the tropics are examples of mutualism. Bees, moths, butterflies etc. derive food from the nectar or other plant product,

and in return bring about pollination. Similarly, the acacia tree provides food and shelter for the ants, and in turn the ants protect the acacia by attacking, stinging, and biting herbivores. The ants also remove flammable debris from around the base of the tree, forming a natural fire break. Mutualism between a fungus and algae forms lichen. There are other associations between animals themselves. The protozoa obtain a habitat (shelter) and food supply inside the termite's digestive system,

while the termites receive a supply of usable nutrients from the digestion of cellulose in wood by the protozoa. Without intestinal protozoa, termites would starve to death, unable to digest the wood they consume. The unicellular green alga, *Chlorella vulgaris* lives within the gastrodermal cells of Hydra. Alga provides food and oxygen to *Hydra*, which in turn provides shelter, nitrogen wastes and CO_2 to *Chlorella*.

2. Protocooperation

Many mutually beneficial interactions are compulsory; that is, both organisms are completely dependent on each other. Protocooperation is a non-compulsory (facultative) interaction that benefits both participants. Here each participant is able to survive independently. For example, the sea anemone attached to the shells of hermit crab is carried by the crab to fresh feeding sites and the crab in turn is protected from its enemies by the sea anemone. The relationship between oxtail bird and rhinoceros is another example of protocooperation. The bird perches on the back of a rhinoceros and removes pests (blood-sucking ticks and flies).

3. Commensalism

In this association between members of different species only one of the participants profits while the other is virtually unaffected. Here two or more populations live together without entering into any kind of physiological exchange. Lianas are vascular plants rooted in the ground and maintain erectness of their stems by making use of other objects for support. They are common in dense forests of moist tropical climates. Epiphytes may grow on trees, shrubs, or larger submerged plants. They use other plants only as support and not for water or food supply.

A variety of microorganisms, saprophytic bacteria and fungi, and protozoans live within tissues or cavities of higher plants and animals. Some microbes are found in lower intestines of animals. *Escherichia* coli is found in human colon. *Treponema macrodentium* live in mouth and *Entamoeba coli* in the intestine of humans. There are several commensals that make temporary contact with other organisms. For example, squirrels, monkeys, tree frogs, snakes, birds, insects etc., use trees and other plants for shelter or breeding sites. Some commensals as oyster crab are found in the mantle cavity of the oyster. In addition to shelter, it also gets food from the host mollusc without causing any harm.

Negative interactions

In this type of interaction one or both the participants are harmed in some way during their life period. These harmful interactions are divided into the following:

1. Competition

Competition occurs when individuals attempt to obtain the same needed resource. This type of interaction harms both participants because each reduces the other's supply of a

needed resource. The more similar the requirements of organisms, the greater their niches overlap, and the greater the niches overlap, the more intense is the competition. In higher plants this is manifested in spatial patterns and in animals by spatial patterns or movements. Because members of the same species require many of the same resources, intraspecific competition between members of one species is often more intense than interspecific competition between members of different species. 'Interference competition' (direct competition) occurs when a competitor prevents another from gaining access to a limited resource. 'Exploitative competition' (indirect competition) results when one competitor secures a greater share of a limited resource than the other, thus reducing the supply of the resource to its competitor.

2. Predation

This type of interaction harms one participant and benefits the other. All organisms need a source of energy and nutrients to survive and reproduce. In predation, one organism (the predator) acquires the needed resources by eating another organism (the prey). Most of the predatory organisms are animals, but there are some plants also that feed upon other animals. Insects and animals such as squirrels, mice, rodents, etc., consume large quantities of seeds as food. Moreover, they browse seedlings of shrubs and trees, and damage most of them by trampling. Carnivorous plants such as Nepenthes (Pitcher plants), Drosera (Sundews), Utricularia (Bladderworts), Dionaea (Venus flytrap),, etc. consume insects and other small animals for their food. Their leaves or foliar appendages produce proteolytic enzymes (enzymes that break down proteins) for digestion of the animals.

3. Parasitism

Parasitism is another type of interaction that benefits one organism and harms the other. A parasite secures its nourishment by living on or inside another organism called the host. The typical parasite lives in its host without killing it, whereas the predator kills its prey upon which it feeds. Although most parasites do not kill their host, the larvae of some insect parasites do. Such larvae are called parasitoids. Most parasites are host-specific; that is, their anatomy, morphology, metabolism and life history are adapted specifically to those of their host. *Cuscuta* (dodder or silkweed plants) is a total stem parasite that entangles its host plant with yellow or orange twisting stems. Outgrowths penetrate the host's vascular tissues and tap its fluids. The total root parasites as *Orobanche*, *Conopholis* and *Epifagus* are found on the roots of higher plants.

Although most parasites use their host only as a source of nutrients, some parasites use their host as a haven for protection from predators. For example, the pearl fish develops and lives in a safe, but very unusual place–the anus of a sea cucumber. As a sea cucumber draws in water for gas exchange through its anus, a newly-hatched pearl fish swims in. The pearl fish remains there, feeding on the host's tissues and taking periodic excursions outside its host to supplement its diet and to reproduce. It always returns to the sea cucumber for protection from predators.

In addition to using a host for nutrients or protection, some parasites exploit the behaviour of their host, an interaction called 'social parasitism'. Parasitic birds as cuckoo, cowbird and honeyguides never build their own nests. Many internal parasites such as the tapeworm are unable to live independently of their host because they lack eyes, a digestive tract, and muscular systems.

4. Allelopathy

In this type of interaction, one organism releases allelochemicals (secondary metabolites, which are not required for metabolism) that harm another organism. Some tropical toads and frogs secrete extremely poisonous chemicals. South American tribesmen simply touch the tip of their arrows to the skin of poisonous toads to produce a lethal missile that can kill an animal or a human within minutes. Other swift-killing poisons are manufactured by the Puffer fish and Goby fish. The monarch butterfly larvae are also poisonous because they eat milkweed plants that synthesize the toxic chemicals; adults are poisonous because the toxic milkweed chemicals are passed on from larvae to adults during metamorphosis. A few poisonous birds (Pitohui birds) are also known. The poison is acquired by eating the Choresine beetle. These birds have bright coloured skin and feathers which contain powerful neurotoxin alkaloids. These toxins serve the birds as chemical defence, either against ectoparasites or against predators such as snakes, raptors or humans.

Some plants manufacture allelochemicals that kill herbivores or competing plants. The chemicals released by some chaparral plants (vegetation composed of broad-leaved evergreen shrubs, bushes, and small trees usually less than 2.5 m tall) accumulate in the soil beneath them and block the germination and growth of other plants, thereby reducing competition for scarce water and nutrients. Members of the crucifer family (cabbages, broccoli, brussels sprouts, mustards, radishes, and so on) produce oils and chemicals that are lethal to many herbivores and disease-causing fungi and bacteria. Some ferns, conifers, and flowering plants produce allelochemicals that disrupt the normal growth and development of insect herbivores. These allelochemicals are virtually identical to the insect hormones that coordinate development during metamorphosis. When larvae consume these plants, the allelochemicals cause premature metamorphosis or produce sterile adults. Either way, herbivore reproduction is disrupted. Some of these hormone-mimicking allelochemicals are being considered for use as natural pesticides, chemicals that would cause considerably less environmental damage than synthetic insecticides.

Dr Amrita Singh is a Science writer and Reviewer.
Email: amrita_arsenic@rediffmail.com

INDIA SCIENCE BAGS COVETED RED INK AWARD

India Science, the Over-The-Top (OTT) science channel managed by Vigyan Prasar has won the Mumbai Press Club's prestigious Red Ink Awards 2021, instituted to honour excellence in journalism. The channel has jointly won the award in the category 'Science & Innovation' for the programme 'World's First Fully Equipped Mobile Covid-19 Testing Lab' produced under the series 'Life in Science with Pallava Bagla'.

The Red Ink Awards covers all formats including print, digital, and television across 12 categories. Considering the on-going COVID-19 pandemic, the awards were presented in a virtual mode on 29 December. The Chief Justice of India N.V. Ramana was the chief guest.

The programme explores India's fully equipped mobile testing laboratory that was established to strengthen India's COVID-19 testing capacity amid growing infections. Fully equipped to conduct the RT-PCR test, the mobile laboratory is designed to take the testing facility to people at distant locations. The award-winning programme featured virologist Dr Guruprasad Medigeshi, as he explained the complexities of COVID-19diagnostic testing. The series is anchored by the well-known science journalist Pallava Bagla.

'Life in Science with Pallava Bagla' is the premier science show on India Science Channel that showcases India's scientific and technological advancements. Several programmes produced by India Science have been nominated for various national and international awards in the past.

India Science is an initiative of the Department of Science & Technology, Govt. of India. The channel is being managed and implemented by Vigyan Prasar, with the support of the National Council of Science and Technology Communication (NCSTC). The channel has been producing documentaries, studio-based interviews and talk shows, outdoor shows, specially conceived programmes, science magazines, R&D features, Innovation features, short films, news bulletins including Live streaming of important events and videos on demand.

India Science is dedicated to science and technology knowledge dissemination, with a strong commitment to spreading scientific awareness especially with Indian perspectives, ethos, and cultural milieu. It can be accessed on any internet-enabled device 24x7–laptop, desktop, smartphones (Android/iOS), smart TVs, etc.

The award winning programme link: https://www.indiascience.in/videos/red-ink-award-2021-winning-film-worlds-first-fully-equipped-covid-19-testing-lab?share_url=true

DEVENDRA MEWARI RECEIVES SAHITYA AKADEMI BAL SAHITYA PURASKAR 2021 FOR NATAK NATAK MEIN VIGYAN

Well-known writer Shri Devendra Mewari received the highly prestigious Sahitya Akademi Bal Sahitya Puraskar 2021 for his book Natak Natak Mein Vigyan published by Vigyan Prasar. This year 22 writers have been selected for this prestigious award for different Indian languages including English. Natak Natak Mein Vigyan has been awarded for Hindi children literature. The award contains an engraved copper plaque and a cheque for Rs. 50,000. Shri Mewari has been associated with Vigyan Prasar for several years and has been supporting the organisation's agenda of SCoPE (Science Communication, Popularisation and its Extension) with his expertise and experience.

Natak Natak Mein Vigyan is an engaging book that contains 29 plays in several interesting and important topics such as Microscope, Radioactivity, Malaria, lives of well-known scientists like SN Bose, MN Saha, and on various other inventions that have changed our lives. Most of the plays have been enacted in channels of Akashvani. The plays have been liked by the readers and listeners for their interesting language, scripts and presentations.

VP Team