VIGYAN PRASAR

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IMPROVE BRAIN FUNCTIONS WITH VIDEO GAMES

3-D PRINTING IN THE FOOD SECTOR

OUR SENSORY ORGANS: THE BODY'S VERSATILE DETECTORS

MILK-BORNE VIRAL INFECTIONS WITH ZOONOTIC IMPLICATIONS

CRYPTOCURRENCY DAWN OF A NEW ERA

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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NAKUL PARASHAR

Welcome 2022

AT THE OUTSET, wishing you all a very happy new year 2022.

Let us hope that this year brings us a lot of happiness, health, and prosperity.

Well, for this, enhancing the scope of SCoPE (science communication, popularisation, and its extension) is essential. We all agree that taking science & technology to everyone has been all-time relevant–SCoPE for all. With COVID-19 around for more than two years now and its fast-surfacing variants, the importance of expanding SCoPE in these times has increased rapidly. Isn't it?

Educating the masses about the importance of vaccination, maintaining COVID-19 safety protocols, and keeping everyone duly aware about the latest that's happening in our fight against the disease is mission-critical. After all, it's all about SSR, the scientific social responsibility. So, how do we do it?

There are many ways to do it; keeping ourselves duly abreast with the latest developments published and disseminated through print-electronic-social-digital media seems one of the prominent ones. However, one needs to be extra cautious about misleading and fake news emanating time and again. Thus, rely on agencies that have proven accountability.

The expansion of SCoPE is gaining momentum. In our celebrations around the 75th Year of Independence, popularly known as the Azadi ka Amrit Mahotsav, weeklong nationwide celebrations of science & technology are being planned in a grandeur manner that shall culminate with the National Science Day. Food and agriculture, atomic energy & power, communication & information technology, earth sciences, forests and environment, space & defence, and every such sector that thrives with science & technology are expected to be a part of this weeklong festival. Let's wish this to be a huge one whence all of this would be in major Indian languages. The number 75 would be the highlight of this festival–75 locations, 75 lectures by eminent speakers, 75 films, 75 winners, remembering 75 scientists, and the list is thus long. There will be several competitions for school and college-going students in the run-up to the week. We're planning for a grand inaugural and a grand finale of this week. Vigyan Prasar, the nation's neutral nodal agency for SCoPE would be driving it.

While all of this is happening, Vigyan Prasar has embarked upon a programme called Remembering the Inspirational Scientists Yatra (Prerak Vaigyanik Smaran Yatra). Launched recently by the Hon'ble Vice President of the country on the National Mathematics Day 2021, this Yatra would be a year-on-year programme. In this Yatra, notable scientists born a century ago would be remembered through various means of communication, popularisation, and outreach, all over the country, in different Indian languages.

For this year in this Yatra, scientists born in 1922 have been identified–Har Gobind Khorana (January 9th), Rajeswari Chatterjee (January 24th), B. Ramamurthi (January 30th), G.S. Laddha (August 26th), Y. Nayudamma (September 10th), and G.N. Ramachandran (October 8th). We plan to organise an expert lecture on the birth date of these luminaries through webinars in different languages across the country.

Besides, stay tuned for several exciting events in this Yatra and many more milestones we intend to cover in the coming year. Stay safe, and necessarily stay happy.

Once again, seasons' greetings to you and your loved ones.

Email: nakul.parashar@vigyanprasar.gov.in

COVER STORY

MAITREYO BHATTACHARJEE

CRYPTOCURRENCY
DAWN OF A NEW ERA

On hearing the word "Crypto", the thing which comes into the mind of most of us is Cryptography, that is the technique of secure communication in the presence of an intruder (interestingly, we will be requiring this concept here as well!). Due to its long and very interesting history spanning several centuries, it has more or less become familiar to a large part of the society.

scotsman.com

But, the concept of Cryptocurrency is still unknown to many. It is an emerging form of digital currency, which has gained immense popularity over the entire world in the last few years. According to some estimates, the total value of all cryptocurrencies (when converted to conventional money) is more than 2.5 trillion USD. Loosely speaking, it is a nexus of Digital Technology, Economics, Computer Science, and Mathematics.

Before going into details, we need to revise few basic concepts. The first is that of currency. Currency, as we know, is one of the most essential components of survival in today's world. It is the very medium of exchange of goods and services used in the society. Different countries have different system of currencies. We use physical wallets to store money (notes or coins) or have bank account. In our country, it is the Reserve Bank of India (RBI) which controls the issuing of notes. Apart from looking after the monetary transaction, its other responsibilities include maintaining the stability of the economy. A fundamental limitation of currency is that it has a certain dependence on location. For example, we cannot freely use the Indian rupee when we are travelling abroad and vice versa. A certain note may become invalid, although its monetary value is never lost, precisely what happened during the demonetization of November 2016. Thus, currency can be subjected to manipulation. A natural question which arises is can a system of currency ever exist, which is completely digital in nature, free from the domination of a central institution, and which gives more power to the users who are using it? In this article, we would mainly focus on how this system works, some important aspects of this system, the advantages due to which the craze for cryptocurrency investments has increased so much, and some demerits of this system.

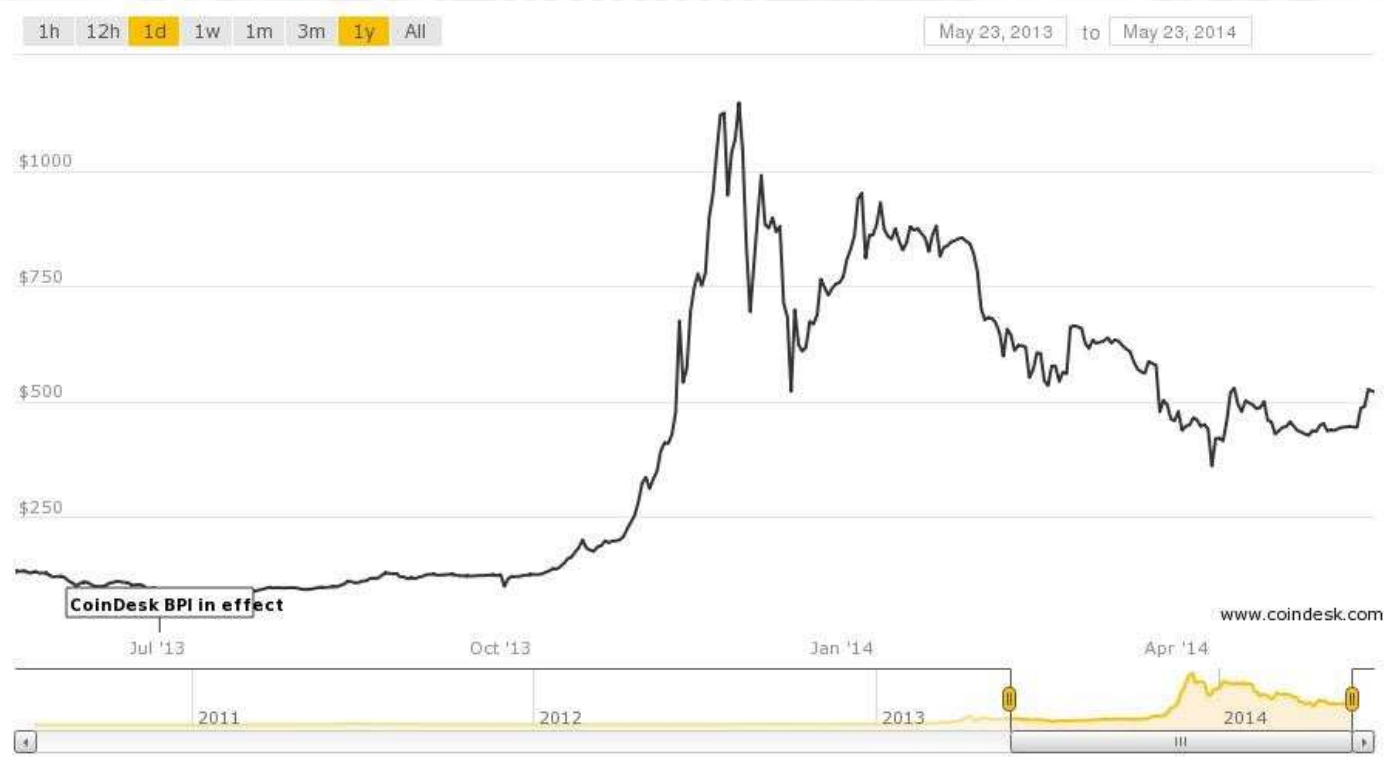
EARLY YEARS

Cryptocurrency is a new kind of private digital currency or digital money, which can be used to pay someone using the Internet. It is radically different from the traditional currency to which we are accustomed. Broadly, they can be viewed as "digital alternatives" to the money issued by the government. It is totally decentralized in nature, that is, a single body cannot exercise total control over it. As the word "digital" will come up often, it is essential to clear one common misunderstanding in the beginning. Cryptocurrency tokens are not the same as the transactions which we do using Credit Cards, Net Banking, e-Wallets, or Debit Cards. There, the medium may be Internet in most cases but it involves government-issued money.

Statue dedicated to Satoshi Nakamoto in Budapest leofinance.io

Now, for some currency to work, some tokens are needed for real-world transactions, like the notes or coins. One such token is bitcoin, arguably one of the most popular digital currencies. This means, in a transaction carried out using Cryptocurrency, a person may send bitcoins as payment to another person, using the Internet. All these digital currencies are actually computer programs, which are written for this purpose. The origin of bitcoin is however unclear. A person, or a group of people (till date, we do not know accurately), under the pseudonym Satoshi Nakamoto, had launched it in January 2009. The program was written in C++. Bitcoin is not under the regulation of the Government, and it is limited (just like Gold). The following are a few important Cryptocurrencies other than Bitcoin, which are also regularly used:

- Ethereum
- Polkadot
- Cardano
- Litecoin
- Dogecoin (seen by some as memecoin)



Rise and fall in value of bitcoins with time coindesk.com

THE GAME OF DEMAND!

Let us consider the following situation. We have a piece of land, and there are several people bidding to own it. As a natural consequence, price of the property soars high. For a similar reason, there is always a rush of people who are racing to buy Cryptocurrencies, when their prices are comparatively low. Value of a thing seldom remains constant, and as far as money is concerned, its value decreases with time (mostly). This means, if we can buy something for ₹500 this year, it may cost us more than that after 4-5 years. Currently, the Dogecoin is the cheapest cryptocurrency to buy, and many people view it as a valuable investment option. As cryptocurrencies are limited, their value depends on their demand. For example, though it started from just ₹10, the current value of Bitcoin is close to ₹40 lakh. Investors always keep a track of this rise and fall in the price of currencies and plan their investments accordingly. The price depends on various factors, like the news, current market conditions, etc. Now, let's see how the safety of all these transactions is ensured.

BLOCKCHAIN TECHNOLOGY (CHAIN OF BLOCKS!)

The Blockchain system plays a pivotal role and is the technology on which Cryptocurrency is based. For ordinary transaction, a record is maintained by the bank. In this case, the same job is performed by blockchain. To define, Blockchain is the decentralized system shared among computer networks which acts as a "digital database", storing information about the transaction made by the users. The structure of this database is as follows: A blockchain is designed to collect information together in groups, known as "blocks". Blocks have certain storage capacities and, when it is reached, they are closed and linked to the previously filled block. Thus, they form a chain and are known as the "blockchain." All new information that

Representation of Blockchain System forbes.com

follows that freshly added block is compiled into a newly formed block that will also be added to the chain once filled. Whenever a transaction occurs, it is authenticated through a series of steps, before getting validated. As far as the question of security is concerned, blockchain is transparent, i.e., it is freely available on every computer which is participating in the verification process, and any mischief done can be detected. The concept of blockchain is also used in other sectors like Tourism, Education and Insurance.

In the domain of cryptocurrency, it is the technology which underpins the bitcoin. There exists something called the Public Ledger, which is a record keeping system. It maintains the participants' identity and data anonymously, using Cryptography. This ledger is not maintained by a single person, but is spread across the systems of huge number of people working on it. This is referred to as the "peer-to-peer network". Special kind of software and computer systems are needed to achieve these sophisticated tasks, and the time limit associated is usually ranges from 10 minutes to nearly an hour. People maintaining all these tasks are called "Miners" and the process is called "Mining".

DISADVANTAGES OF THE SYSTEM

Every system has got its own set of pros and cons, and this one is no exception. Though it may sound to be extremely lucrative, one of the key disadvantages is that the users do not have any specific authority to report their complaints, as the network is huge and no such omnipotent institution exists. Also, this may be used for various unethical tasks, especially by people who fake their identity. Let us assume that a person 'A' buys some item worth ₹25 thousand from 'B' and wants to pay in Cryptocurrency, but 'B' turns out to be a fraud. If 'A' would have used normal currency, then some bank would have stored the record. But, in this system, as everything is virtual, and 'B' provided some incorrect ID to 'A' for receiving the payment, the task of tracking down 'B' gets very difficult. With digital currency, however, there is a risk that a holder of the Cryptocurrency can make a copy of the digital token and send it to another party or merchant while retaining the original.

INDIA'S POLICY TOWARDS CRYPTOCURRENCY

The Ministry of Finance, Government of India has stated that Bitcoins will not be accepted as a valid currency in India. This

A block chain is designed to collect information together in groups, known as "blocks". Blocks have certain storage capacities and, when it is reached, they are closed and linked to the previously filled block.

means, we cannot use them to buy a gadget or pay for a service. The RBI anticipates that Cryptocurrency possess a threat to the financial stability of the country. However, many sections among the Government have insisted on introducing some measures on regulation of cryptocurrencies, and not entirely banning them. More recently, there have been speculations that the Government is going to bring a new bill regarding this system. For a country like India, where a large portion of the society is not that tech savvy yet, use of Cryptocurrency may not be catching up fast. The Indian Government is not looking to ban them but regulate them as assets. All Indian crypto exchanges will reportedly come under the purview of the Securities and Exchange Board of India (SEBI). Indian citizens will no longer be allowed to hold their crypto assets on foreign exchanges or in private wallets, it is said by some sources. India is, however, working on its own central bank digital currency (CBDC) that will be governed and monitored by the RBI.

Cryptocurrency has opened up a vast new area for the future generations. It is still an emerging market, and a lot of progress is yet to take place. The hugely interdisciplinary idea behind it is definitely innovative, but for it to function more efficiently, a greater number of people need to be aware of the various aspects associated with this system. A few years back, many people had problems with digital payments gateways. But now, they have become quite habituated with it, and in fact there are several places, like the Toll Plazas on highways, where e-payment is being used extensively. Digital literacy is after all essential to live in today's time. The system of Cryptocurrency as an alternative to physical currency may bring about a revolution in the way society works and will be a familiar name in the coming few years.

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The author is a Science and Mathematics enthusiast, a college freshman at IACS Kolkata and a Life Member of the Indian Mathematical Society.

Email: maitreyomaths@gmail.com

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DEBOJIT ACHARJEE

Improve Brain Functions with Video Games

A video game is a kind of electronic game that is played on an electronic device with the help of a user interface like a gamepad or a joystick, and the game is displayed with an inbuilt display unit or on an external display device like a TV screen or computer monitor. Video games can be played on a TV or a desktop computer but now-a-days, people like playing video games on their mobile phones also. Even though video games are played by many for entertainment only, some video games can help improve our brain functions too. This can happen because of virtual environmental enrichment while playing a video game and its stimulation on brain function.

Brain function and environmental enrichment

Our brain is made up of many neuron cells that are linked to each other by forming a neural network. These neurons are responsible for sensory processing, motor control, autonomic functions, emotion and cognition. Therefore, functioning of the brain depends on how the neuron cells behave. The neuron cells present in the cerebral cortex of the brain are mainly involved in attention, perception, awareness, thought, memory, language, and consciousness. The functional development of the cerebral cortex depends on environmental stimulation and it can also be done with the help of environmental enrichment.

Environmental enrichment is the process by which the brain function is influenced through the stimulation of the brain by its physical and social surroundings. In richer and more stimulating environments, the brain has higher rates of formation of synapses between neurons and more complex dendrite branching, leading to increased brain activity. Therefore, environmental enrichment can help prevent many brain-related disorders like Alzheimer's disease and dementia. It can also help improve the cognitive reserve of the brain. A cognitive reserve is the brain's ability to cope with increasing damage while still functioning adequately.

Canadian psychologist Donald O. Hebb in 1947 found that rats raised as pets performed better on problem solving tests than the ones raised in cages. American psychologist Mark Rosenzweig at the University of California, Berkeley, USA, in 1960 observed that rats placed in cages with toys, ladders, tunnels and running wheels had increased cerebral cortex volume with enzyme cholinesterase activity than single rats in normal cages. This happens because enriched environments affect the expression of genes that determine neuronal structure in the cerebral cortex and hippocampus. At the molecular level, this occurs through increased concentrations of chemicals called neurotrophins NGF, NT-3 and changes in brain-derived neurotrophic factor (BDNF). This alters the activation of some cholinergic neurons (nerve cells which mainly use the neurotransmitter acetylcholine, Ach, to send messages).

A study conducted in 2011 led to the conclusion that environmental enrichment vastly improves the cognitive ability of children with autism. Research has indicated that environmental enrichment can help relieve motor and psychiatric deficits caused by Huntington's disease. A 2013 study also found that environmental enrichment benefits patients recovering from stroke.

Therefore, it is scientifically understood how environmental enrichment can help the brain improve its cognitive function and the same can be done using video game too.

Video games and brain function

As environmental enrichment can improve the brain function, playing certain video games can also help

improve the cognitive function of the brain. It is seen that children who play video games develop better cognitive skills and better learning abilities. This happens because video games can provide an environmental enrichment virtually. New research done by the researchers at Yale University (USA) found that children who play video games are always good at learning.

Your brain is yours... if you don't use it, you lose it! Many age-related brain disorders like Alzheimer's disease can progress in people who don't work on activities involving brain. One research shows that people who play puzzles and board games frequently are less likely to develop Alzheimer's disease. So, playing board games and puzzles on your PC or mobile can also help reduce the risk of brain-related disorders because it gives better environmental enrichment to improve the cognitive reserve.

People or children who live a socially isolated life often show delay in cognitive and social development. This is because they don't get that environmental stimulation required for the brain to develop properly. However, such individuals could improve by playing life simulation games like Sims4 or any other immersive games because such games give a virtual environmental enrichment equivalent of a social life.

Playing puzzle video games like Bejeweled, Tetris, Solitaire and word games like Scrabble can help in improving learning abilities and memory.

Apart from Alzheimer's disease, some video games might also cure mental disorders like ADHD. Games like Project Evo and Akili are designed to cure ADHD but are waiting for FDA's approval. Video games are also good stress busters, and a new study of millennial gamers has revealed that video games can help reduce mental stress. The Behavioural Science Institute in The Netherlands has found that some video games can help reduce mental stress. The fact that video games can improve cognitive function was also published by The National Center for Biotechnology Information of Bethesda, Maryland USA.

Video game rating

Video games are rated by the Entertainment Software Rating Board (ESRB) of USA according to the age group. ESRB rates games that are designed for everyone as 'E', above 10 years are rated as 'E10+', for teens between 10-17 years of age are rated as 'T'; games that are for above 17 years of age are rated 'M' and for 18 years and above games are rated as 'A'. If video games are played by the suitable age group, it will not cause any psychological problem. However, some video games are often played by the unsuitable age groups by means of piracy or if the game is free to download, and that could have psychological effect on the users.

Future of video games

Due to the advent of new technologies, video gaming experience has gone to another level. Previously video games were only played on game consoles but now people can also play on their smartphones. Apart from using gamepads and touch screens, a new technology called gesture control helps playing video games only with hand movements and gestures. This technology has made playing video games lot easier and suitable for people of all age groups. Virtual Reality (VR) is another new technology that allows users to experience video games or any 3D simulator in a 3D environment with the help of a VR headset. In VR gaming, one can actually feel the presence in the gaming environment and can visualize everything around them virtually. Apart from gaming, VR is also used for simulation and training purposes.

VR can also be used for educational purposes like helping doctors to operate on human body using a surgery simulator (video game). VR technology is most useful in perceiving things easily because it gives a real-life like experience. Besides VR, there is another technology called Brain Computer Interface (BCI) in which a headset is used to communicate with the computer from the brain directly using electrical signals, and it can be used as a control device for video games also.

As technology improves, video games become more and more enjoyable and useful. Starting from game consoles to touch phones, video games are enjoyed by people of all age groups, and even though video games are mostly played for entertainment, playing the right game can help to improve the brain function.

The author is a Software Engineer.
Email debojitacharjee@gmail.com

VISHAL RAI, MUKESH BHATT, AJAY KUMAR YADAV, ASHOK KUMAR, KIRAN, AND KAUSHAL KISHOR RAJAK

MILK-BORNE Viral Infections with Zoonotic Implications

Consumption of raw milk or milk-products is a common practice, especially in developing and underdeveloped countries. This is mostly due to lack of awareness about the harms such practices can cause. Milk-borne viral infections are an example of one such harm. Some viruses found in animals that can infect humans are secreted into the milk of affected animals, from where they can pass on to humans and cause human infections if the milk is not pasteurized.

Zoonotic diseases or infections are diseases which are known to be transmitted naturally between vertebrate animals and humans; animals play a vital role in maintaining them in nature. Viruses are one of the agents involved in causing such infections and milk is the animal source from which these viruses can pass on to human. Nonetheless, it can happen, particularly in situations where there is negligence in handling and storage of milk and milk-products or with consumption of raw milk. So, people should be made aware of these potential milk-borne viral pathogens if the milk or milk-products are consumed without making them safe for consumption.

MILK-BORNE VIRAL DISEASES

1 MIDDLE-EAST RESPIRATORY SYNDROME (MERS)

The causative agent is MERS coronavirus (MERS-CoV), a member of the genus *Betacoronavirus* and family *Coronaviridae*. Similar to SARS-CoV-2 (the causative agent of COVID-19), MERS-CoV emerged as a zoonotic pathogen in 2012. Camels are thought to act as the reservoir for the virus. Although less widespread than COVID-19, infection with MERS-CoV in humans is more severe and characterised by symptoms associated with respiratory distress and a case fatality rate of 35%.

2 HEPATITIS

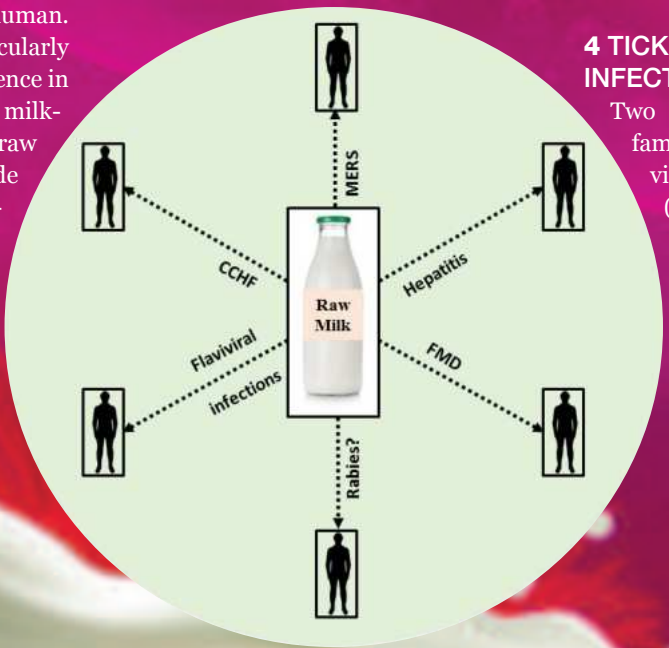
Out of the five types of hepatitis virus, Hepatitis E virus (HEV) is a recognised agent that causes zoonotic disease. It is a member of the genus *Orthohepevirus* in the family *Hepeviridae*. HEV is a virus with a wide host range and has been demonstrated in humans and different animals including cattle, deer, rabbit, and pigs. In infected cows, the virus has been demonstrated to be excreted in milk and was found to be resistant to pasteurization. However, a short period of boiling can completely inactivate HEV.

3 FOOT AND MOUTH DISEASE (FMD)

A virus of the genus *Apthovirus* under *Picornaviridae* family, named foot and mouth disease virus (FMDV), is the causative agent of FMD in animals with split hoof and can be considered one of the rare viral zoonotic diseases. Though it is a devastating disease of animals, human infections are mild, self-limiting, and characterised by sore throat, fever, accompanied by development of uncomfortable tingling blisters on the hands, feet and in mouth. There is a historical report according to which three veterinarians acquired the disease in 1834 after deliberate consumption of raw milk from infected cows.

4 TICK-BORNE FLAVIVIRAL INFECTIONS

Two viruses of the *Flaviviridae* family -tick-borne encephalitis virus (TBEV) and louping ill virus (LIV)-have known potential to cause human infections by transmission through milk of affected animals. Louping ill is a viral infection that often causes fatal encephalitis. The disease primarily affects sheep and red grouse, but cattle, goats,



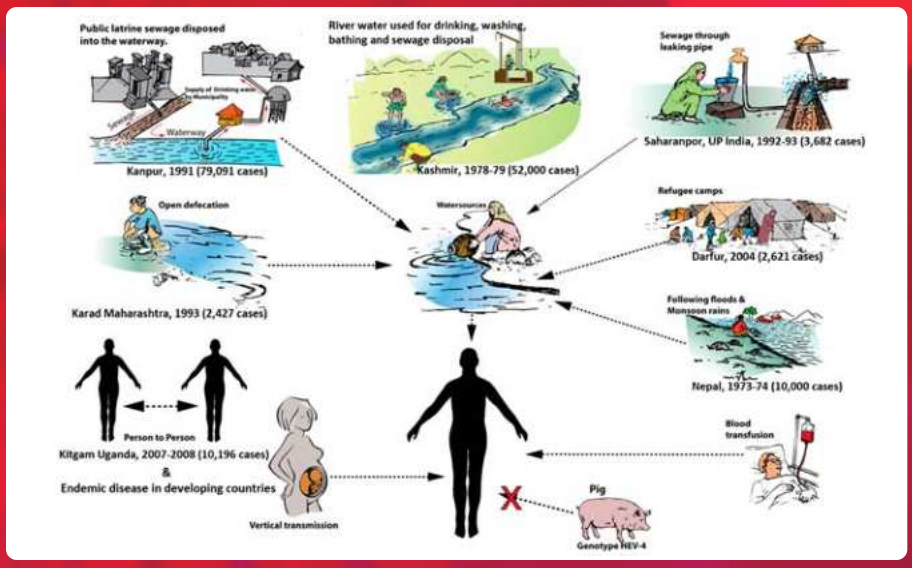
Viral zoonoses transmitted through consumption of raw milk (The animal source of milk is not depicted and the image is for representational purpose only).

horses, dogs, pigs, and humans also can be affected. TBEV is found predominately in the milk of goats and sheep rather than cows. Louping ill in humans is manifested in the form of flu-like illness such as fever, malaise, joint pain, muscle pain, and headache in the first phase. Some cases progress to the second phase where similar but more severe symptoms are seen with additional neurological signs like drowsiness and mild to severe paralysis. As the virus is secreted in milk of the affected animals, there is a possibility that humans might contract the infection if they consume unpasteurized milk from small ruminants. Tick bite is the main route of transmission for this virus; however, cases occurring as a result of consumption of unpasteurized goat milk from diseased animals have also been reported.

The natural hosts of another flavivirus, namely alkhurma hemorrhagic fever virus (AHFV), the causative agent of alkhurma haemorrhagic fever are camels, sheep, and goats. In humans, this tick-borne disease is characterised by non-specific flu-like illness in the first phase and haemorrhagic and neurologic symptoms in the second. Transmission through consumption of unpasteurized milk was described as a mode of transmission, but such cases have not been documented yet. Nevertheless, there is a need for caution from this virus as related flaviviruses have been shown to be secreted in milk.

5 RABIES

Rabies is a fatal disease of warm-blooded mammals, including humans, caused by rabies virus. Bite or licks from rabid animals is the major mode of transmission and the disease in humans is characterised by dysfunction of the central nervous system. An estimated 59,000 human deaths worldwide annually are attributed to rabies, with 95% of the total cases occurring in



Transmission of Hepatitis E Virus in Developing Countries (https://www.mdpi.com/1999-4915/8/9/253/htm)

African and Asian countries. It is theoretically possible for humans to get infected on consumption of milk from rabid animals, although such confirmed cases have not been reported yet. As per the advice of WHO, drinking raw milk from infected animals is not advised albeit it can be consumed after pasteurization.

6 CRIMEAN-CONGO HAEMORRHAGIC FEVER (CCHF)

Crimean-Congo haemorrhagic fever virus (CCHFV) is the causative agent of this widespread tick-borne disease. Hosts such as cattle, goats and sheep do not show clinical signs, but humans exhibit symptoms associated with severe haemorrhagic fever, with a case-fatality rate of 15-40%. Boiling milk properly before consumption has been suggested as one of the preventive measures for this disease.

There is no doubt that milk is a complete food for humans. But there are several prevailing misconceptions that raw milk is more nutritious and beneficial than pasteurized milk. However, these myths have already been busted by several scientific studies and that some sort of heat treatment is required to make milk safe for human consumption. The transmission of almost all the aforementioned milk-borne zoonotic viruses have been linked to consumption of raw milk and these viruses are susceptible to pasteurization and/or boiling. The destructive effects of a virus have been exemplified by the emergence of COVID-19. So, to safeguard human health from these known existing viruses and prevent emergence of new viruses, people should be made aware and advised to consume milk only after thorough boiling or pasteurization.

Vishal Rai, Ashok Kumar, Kiran, and Kaushal Kishor Rajak are with ICAR-Indian Veterinary Research Institute, Izatnagar, Bareilly; Mukesh Bhatt is with ICAR-National Organic Farming Research Institute, Tadong, Gangtok; and Ajay Kumar Yadav is with ICAR-National Research Centre on Pig, Rani, Guwahati. Corresponding authors: roger.vish@gmail.com, kaushalvirol@gmail.com

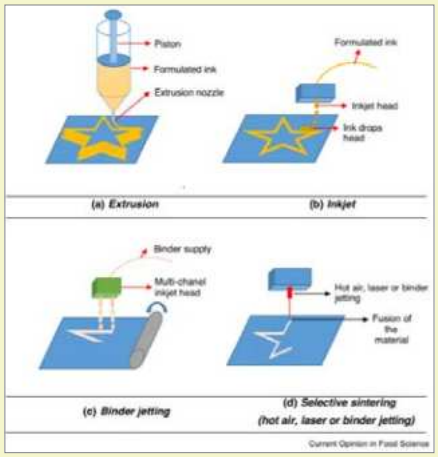
BIJU DHARMAPALAN

3-D Printing in the food sector

Image Courtesy: www.foodjet.com

Innovation is the key for any industry and the food sector is no exception. The traditional food industry is on the verge of a revamp. The growing interest of consumers for specific expectations related to food composition, food structure, and food properties, in general, resulted in the emerging trend of personalized foods and personalized nutrition. This motivates a growing market for personalized food, which aims to tailor and fabricate a diet specifically based on an individual's health condition. The food industry is also motivated by this technology, even though so far most of the applications are concerning food prototyping. In the last couple of years, numerous studies on three-dimensional (3D) food printing have demonstrated the value of this technology in the food industry for production of personalized food.

A 3D food printer comprises a food-grade syringe or cartridge that holds material, a real food item, and deposits exact fractional layers through a food-grade nozzle directly onto a plate or other surface in a layer-by-layer additive manner. Another method is a mould-based method wherein 3D printing food machines are used to give shapes to a dough with the help of a hollow container or moulding box. 3D printing requires hardware and software to work in collaboration. Advanced 3D food printers are equipped with user-friendly interfaces and pre-loaded recipes with designs that can be easily accessed by the computer or even with a mobile or IoT device.



Different types of 3D printing technologies

Different types of 3D printing technologies

Extrusion-based printing

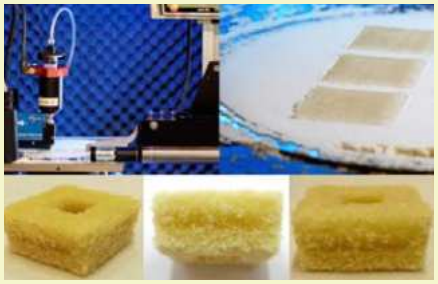
The extrusion-based 3D printing is considered to be the easiest to develop and has the widest set of foods made with it. This technique involves a robotic arm with a cylinder (i.e., a syringe) that moves along a surface, extruding material through a nozzle. The consecutive deposition of layers is undertaken by directing the cylinder at pre-determined locations by a 3D model. The syringe-based extrusion printer typically uses food pastes of high viscosity. The food ink is extruded through a die or printing head and is expected to have a viscosity/ mechanical property allowing a vertical assembly (self-supporting slurry).

Inkjet printing

The inkjet printing technology applied to food printing uses an array of pneumatic membrane nozzle jets that lay tiny drops of food ink onto a moving object. The drops together shape a digital image in the format of a graphical decoration, surface fill, or cavity deposition. Inkjet printers generally handle low viscosity materials; therefore, it is rather used to print drawing on flat products rather than in the case of the construction of complex food. Temperature is an important factor in ink jetting, as it can be used to modify the rheological properties and surface energy of the inks. This technique has been applied mainly for confectionary and decorations.

Binder jetting

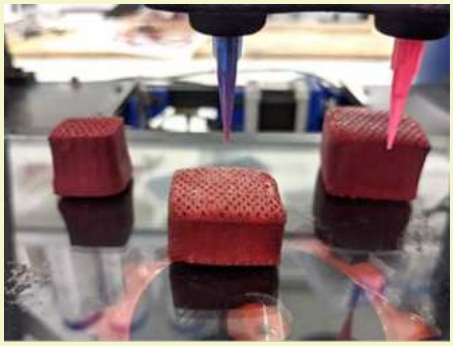
Binder jetting is an additive manufacturing technique, in which powdered material is distributed evenly across the fabrication platform, and



a liquid binder sprays to bind two consecutive powder layers. For each layer of the part, a layer of powder is spread typically using a counter-rotating roller. Afterwards, an inkjet print-head jets the liquid binding agent to the powder bed to create the 2D pattern for the layer. This technique shows advantages such as fast fabrication and low material cost; however, the objects that are obtained show rough surface finish, meanwhile the cost of the equipment is rather high.

Selective sintering

Selective sintering can be classified into two types in relation to the type of the sintering used: selective laser sintering (SLS) or selective hot air sintering and melting (SHASAM). The principle of this technique is the same for SLS and SHASAM, which uses a sintering source to fuse powder particles and form a solid layer.



Once the first layer is completed, a roller distributes a new layer of powder on top of the previous one. The object is built layer-by-layer, which is then recovered from underneath the powder bed.

The Advantages of 3D Food Printing

With 3D printers now becoming more affordable for the average consumer, 3D food printers are getting ready to boost culinary creativity, nutritional and ingredient customizability, and food sustainability. Some of the advantages of 3D food printing include the following:

- Saving time and effort: 3D printing food can save both time and energy when it comes to experimenting with cocktail garnishes or chocolate/sugar cake toppers. Even a trained pastry chef cannot achieve the perfection that 3D printing can.
- Innovation in healthy food: Today, 3D printing has gone beyond the kitchen. Chloé Rutzerveld, a Dutch food designer has used food printers to create cracker-like yeast structures with spores and seeds that sprout with time. She feels that snacks like this and other such natural and transportable products will transform the food industry someday.
- Food sustainability: 3D food printing has the ability to supply an ever-growing world population as compared to traditional food manufacturing systems. At the same time, food printers could also minimize waste with the use of hydrocolloid cartridges that form gels when combined with water. Even rarely used ingredients like duckweed, grass, insects or algae can be used to form the basis of familiar dishes.
- Personalized reproducible nutrition: As 3D food printers follow digital instructions, the idea of being able to make personalized food containing the correct percentage of nutrients for a particular age or gender does not seem so far off. Food printers can easily help determine the exact quantity of vitamins, carbohydrates, and fatty acids as per the input. This could be extremely important in hospitals where restricted diets are more common and offer the potential for easy patient customization.
- Unconventional food consumption: Insects and algae are not considered socially acceptable foods in most cultures, but if they are dried and ground into powders, they could be added to other ingredients to produce edible and nutritious foods. Some printers can make 1.5 ton of meat substitutes per hour. Some have developed hybrid meat analogue from animal and plant cells that chews like sirloin.
- Easy reproducibility: Sharing recipes could be as simple as transferring a digital file over the Internet. All that would be required is the same raw materials, printing settings, and compatible printing equipment.
- Accessibility to food at times of disasters: The technology can be used for onsite production of food materials making ease in logistics. This makes the technology invaluable during times of disaster when a region might not have access to transport and thus food.
- In Space travel and space colonies: Since 2000, the International Space Station has been home to over 100 space travellers. Constrained by microgravity and lack of refrigeration, the current food system in space consists of fully processed, individually packaged foods. This food system is further limited by mass, volume, water, and crew time constraints. The current food system wouldn't meet the nutritional needs and five-year shelf life required for a mission to Mars or other long-duration missions. By combining vitamin and mineral mixtures, flavours, colours, and oils to the pastes, the 3D-printed foods could be tailored to meet the personal nutritional needs and taste preferences of each crew member. They would be able to create a diverse menu with minimal waste. The 3D printing technique would also help next-generation humans who will build space colonies in the near future.

The commercial use of 3D printing is still in the nascent stages, but applications of the technology could be a game-changer. Many restaurants like London based Food Ink developed by Antony Dobrzensky have adopted this technology, where all the food, the cutlery, on the furniture are printed.

The current 3D printing technology is indeed limited by cost, time, and amount of production on a large scale. Currently, this technique cannot be considered as a replacement for conventional food manufacturing, but rather as a way to produce customized foods as prototypes or small production with very specific geometries or functionalities in terms of textures, flavours, appearances and nutrition profile. However, its adoption as a mass production technology still requires a lot of efforts and investigations.

The author is a Science Communicator and Former Head, School of Biosciences, MACFAST, Tiruvalla, Kerala.

Email: bijudharmapalan@gmail.com

BHUPATI CHAKRABARTI

OUR SENSORY ORGANS: The Body's Versatile Detectors

Our sensory organs are extremely important for us; however, they have some limitations too. We as human beings have not only survived against so many odds of nature and our surroundings with their help but have actually flourished with time. However, we need not consider our sensory organs to be omnipotent. We should look at our sensory organs as special kinds of detectors that are capable of handling particular types of signals. The brain takes up the responsibility of interpreting the signals like the central processing unit (CPU) of a computer.

Let us start with our eyes. Scientists have divided the broad range of electromagnetic (EM) also known as electromagnetic radiations into various categories based on their characteristics that are related to their wavelength and hence energy. If we consider our eyes to be the detectors of electromagnetic radiation, we have to admit that it is a detector with very limited capability. It can actually detect only a very, very small range of electromagnetic radiation.

The electromagnetic spectrum ranges from long-wavelength radiations called radio waves at one end to extremely short-wavelength radiations called gamma rays at the other. But the human eye can detect EM radiation only in the visible wavelengths that range from 380 to 750 nanometres (400×10^{-9} m to 750×10^{-9} m), also known as the 'visible spectrum'. Apart from visible light, our body can also sense infrared radiation which is not visible but can be felt as heat.

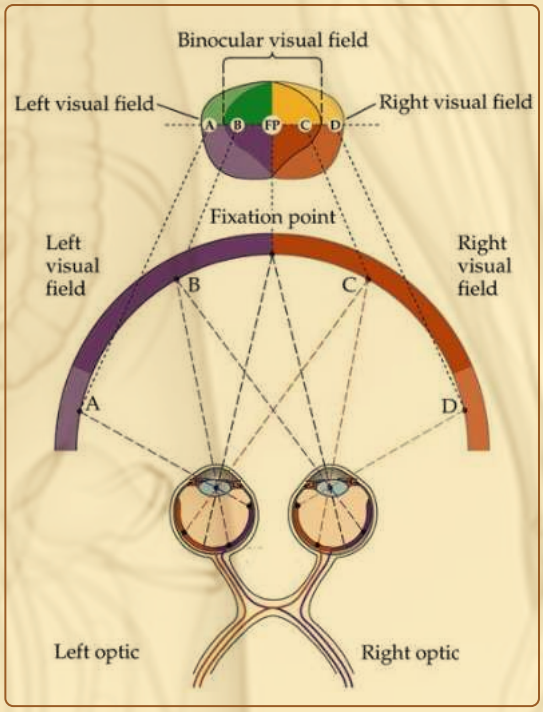
Skin as one of our sensory organs that immediately sends signals to our brain and the brain deciphers it and accordingly controls the movement of our limbs. Heat is a form of electromagnetic radiation that our skin can sense. The skin on our arm is sensitive to a temperature range of roughly 50°C to say down to -10°C and is quite sensitive to touch.

Since human sensory organs have limitations, scientists have developed electronic sensors and detectors for sensing and detecting non-visible electromagnetic radiation. Suppose you are sitting in a closed room with all the doors and windows closed. There is no indoor source of light and neither can any external light enter the room. Hence the room is completely dark. You may be listening to a radio programme indicating there are other sources of EM radiation. Now you keep your eyes wide open. Do you expect to see anything? You cannot, as human eyes cannot see when visible light is absent.

The exercise called 'seeing' actually involves a number of steps, two of which are most fundamental. Without going into the complex physiological process associated with our vision and the role of brain in getting the image of the object and our subsequent physiological or psychological reaction thereof, let us confine ourselves to the domain of physics only.

So far as our eyes are concerned, the range of wavelengths we have talked about is indicative of its qualitative characteristics. We have not talked about the intensity of the EM waves that our eyes can handle. It is well known that looking directly at the Sun is likely to damage the eyes, mainly because sunlight also carries heat; although the radiation coming from the Sun is mostly in the visible region. But it is not the type of radiation but the intensity of radiation that matters. Radiation with a particular wavelength has a specific energy given by the Planck's equation. So, higher the intensity of light, higher will be energy of photons landing on our eyes which the latter may not be able to handle.

The range and ability of our eyes are also intimately connected with two more things. A pair of healthy human eyes has a total field of view of approximately 200° horizontally. That means our eyes can cover objects located in front of us and coming not only within 180° but something beyond that. About 120° of the horizontal field of view can actually be shared by both the eyes and it gives rise to what is known as 'binocular vision'. So far as the vertical coverage is concerned, eyes can cover 135° vertically, and these capabilities tend to get reduced with age. In the field of sports and games, these abilities are very important for the high level of performance. Since our eyes are positioned practically in front of our head and not to its sides, the range gets defined based on that. The ability to see two distant objects separately is called the resolution of an optical instrument. In this regard the eye has a resolution of 30 cm at a distance of 1 km. This means, our eyes can clearly distinguish between two objects 30 cm apart and standing at a distance of 1 km from us!



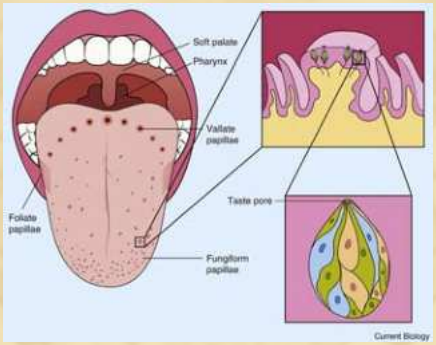
Human binocular vision processing principle (Source: A New Post-Processing Method for Stereo Matching Algorithm, ResearchGate)

Our ears are also important sense organs. They detect sound which are mainly produced by mechanical vibrations. Thus, the signals our ears can detect are completely different from those detected by our eyes.

The main difference between EM waves and sound waves is that the former can move through a vacuum while the latter needs a medium to move through. We know our ears can theoretically pick up any sound of frequency between 20 Hz and 20 kHz and that is indeed a very wide range. We call this range of mechanical waves as sound waves as our ears can detect them. If we compare this with the range of frequencies our eyes can pick up, we find the ratio of the highest and the lowest frequency here is one thousand, whereas for our eyes this ratio is less than two. Moreover, like any detector, our ears can operate for a range of permissible intensities, and this range of intensities is remarkable. They can pick up a very wide range of intensities. We can detect intensities as low as 10^{-12} Wm^{-2} (watts per metre square) and as high as 1 Wm^{-2}.

One may ask why we describe high-intensity sound as 120 decibels and the low-intensity ones as about 20 decibels, a ratio of barely 6? This is because, for the measurement of sound intensities we use a logarithmic scale which is different from a linear scale. Since we have such a huge range of intensities handled by our ears, a logarithmic scale is best suited for this. When we talk about say 90 dB of intensity, we are actually taking the ratio of a particular intensity with that of the lowest perceptible intensity, i.e., with 10^{-12} Wm^{-2}. And then we take logarithm of that ratio. If that ratio is 10^9 then the logarithm to the base yields a result 9. Of course, that gives us intensity in 'bel' (B), a unit named after Alexander Graham Bell. To make this unit more convenient to handle, we use decibel (dB), i.e., one-tenth of bel and this intensity instead of being 9 bels becomes 90 decibels. Thus, a 90 dB sound is actually 10^9 times more intense than the lowest intensity sound that our ears can detect. That way, we may term our ears as the most sensitive sensory organ covering the widest range of intensities.

Our tongue is sensitive to chemical molecules that come in contact with it. There are different regions on our tongue capable of detecting various types of tastes more effectively. When not one but several molecules land on our tongue it sends the right kind of signal to the brain that deciphers it. And once again, there are limits to the intensities of these signals that our tongue can handle. For example, if there is no salt in a curry our tongue will give a signal indicating the lack of salt, but at the same time, if there is too much of salt, a suitable signal will be generated indicating dislike. If the number of molecules that give rise to a particular taste do not reach the threshold level you may not get the taste at all.



Taste papillae and taste buds of the human tongue
(Source: ScienceDirect)

The tongue has a memory and can store its likes and dislikes for a wide number of tastes. This gets developed on the basis of our food preferences, geographical locations and social habits. Due to this, we often find that a highly preferred dish in a certain part of the world may not satisfy the taste buds of the persons from another part of the world.

Nose is also a sensory organ that works not with the distant signals but on the basis of contact of molecules entering it. The molecules may come drifting from a distance. The number of molecules that we need to have the sensation of a smell also depends on the nature of the molecules. We had very little knowledge about the mechanisms that provides us with the sense of smell till 1991, when two US scientists Richard Axel and Linda Buck could identify the existence of about 1,000 genes that encode the olfactory receptors inside human nose. They also could show that each receptor is capable of receiving a small number of odours. Eventually, they won the 2004 Nobel Prize for Physiology or Medicine for "their discoveries of odorant receptors and the organization of the olfactory system". We know how important it is because a smell is often connected to our memory. Smell may make us nostalgic, may take us to our childhood and so on. Of course, this part is governed by our CPU, i.e., our brain.

The abilities and the range of functioning of all our sensory organs described in this article refer to a healthy young person. We go on losing the capabilities with age and some of our abilities may take different turns depending on the surroundings and habits. For example, some people may be tuned to a specific smell from the nearby industry as they are living there for a long time. Sometimes younger people living by the side of a railway track with incessant sound tend to show poorer response to some sounds.

Different animals have different ranges of capabilities of their sensory organs, which help them to survive in their own way. Human beings lack the ability of elephants in detecting infrasonic (very low-frequency) sound or the ability of bats to detect ultrasonic (very-high frequency) sound. For vision also we have capabilities and limitations compared to other animals as we do not have the so-called 'night vision' which many animals have. An animal and a human being both adjust with the surroundings and handle the issues and events taking place around them with their sensory organs by judiciously putting them to use. Yet human beings have ruled over the animal world. One of the greatest achievements of humankind is perhaps its aptitude to extend the domain of capabilities of its sensory organs. We have been able to reach even where our sensory organs do not take us unaided. And that is the strength of humanity.

The author was a Professor at the Department of Physics City College and was the General Secretary of the Indian Association of Physics Teachers.
Email: chakrabhu@gmail.com

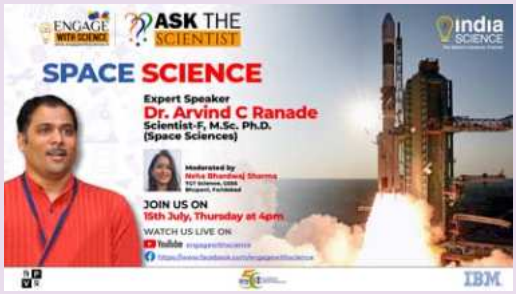
ENGAGE WITH SCIENCE

AN INITIATIVE IN COLLABORATION BETWEEN VIGYAN PRASAR AND IBM

Engage with Science (EWS) is an interactivity platform aimed at school students and teachers, that makes use of gamification techniques and virtual incentivisation to make science learning and teaching a lot of fun. It works as a catalyst to boost consumption of science and technology video content from the India Science channel and also kindles interest about science and technology in general.

Started with the sole purpose of increasing the reach of India Science, EWS has now grown into a platform where several registered schools of India have come together to participate in multiple activities offered. EWS is the youngest foray of Vigyan Prasar in collaboration with IBM.

Unlike other education-centric projects/products, EWS is one-of-its-kind programme that is perennial, focuses on STEM community creation at the school level, actively generates engagement, and develops scientific temper among students. It also enthuse them in pursuing STEM subjects for higher studies and career aspiration.



ENGAGEMENT

Once a school is officially registered and on-board, the focus is to engage the audience with STEM-related content, events, workshops, and contests with the objective of fostering an ecosystem of science enthusiasts. This is achieved in the following two ways:

- **India Science Channel:** An OTT TV channel dedicated to scientific and technology knowledge dissemination. There are over 2500 videos focusing on various scientific topics as well as India's contribution to S&T.
- **Events/Activities:** A variety of events and activities have been designed targeting various stakeholders in the school eco-system such as students, teachers, principals, and the larger school community. Details of these activities can be found here: bit.ly/ewsbrochure

OUTREACH

The primary objective of the initiative is to reach out to large student audiences in the age group of 10 to 16, across the country to inculcate a scientific temper and quest for scientific knowledge. One of the ways this is being achieved is by making the vast repository of scientific content available on the India Science Channel accessible to them. Therefore, the first objective of the program is to reach out to schools and bring them into the fold of the programme.

The program has reached out to 18,000 schools till date across India through school and government partnerships.

Reputed actor Sharman Joshi is the brand ambassador of Engage with Science. It makes students and teachers even more excited to participate in activities and events.

EWS team

7th INTERNATIONAL SCIENCE FILM FESTIVAL OF INDIA 2021

Seventh International Science Film Festival of India, a part of India International Science Festival took place during 10-13 December 2021 in INOX, and Entertainment Society of Goa (ESG) Panaji, Goa. This edition of the Festival was especially celebrated in commemorating the 75th Year of Indian Independence. This year over 700 films were received, and they were meticulously pre-screened by a panel of experts to shortlist 94 films for the competitive and non-competitive categories. Other than India, entries were received from Australia, Bulgaria, Canada, Germany, Israel, Nigeria, UAE, UK, etc. The four-day-long event saw hundreds of people participating physically and huge number of people joining online across the world.. Directors of some of the films were present for a lively interaction with the audiences during which they narrated their journey and shared interesting anecdotes with the audiences. Along with that several master-classes and panel-discussions were organised, that were conducted by eminent filmmakers, scientists, and science communicators. A workshop by well-known filmmaker Nandan Saxena titled Post-pandemic Filmmaking: Quark Workshop drew huge participation. Panel discussions titled Science Communication, Popularisation and Extension (SCoPE) for Filmmakers and Communicators in India @75 and SCoPE and Structure of Science, Environment and Health Communication in Mass Communication, Films and Journalism Studies were organised. Master Classes on Science Programming for India Science OTT Channel and Story Telling and Science Communication were quite informative for the participants.

This year, films were invited under two competitive categories: Science@75 and Science for Everyone. After great deliberation by a distinguished team of juries, winners were announced at the Prize Distribution Ceremony held at the INOX Auditorium on 13 December. Dr Shekher C. Mande, DG, CSIR and Secretary DSIR and Dr M. Ravichandran, Secretary, Ministry of Earth Sciences were present for the function and presenting the awards to the winners. Members of the Jury, scientists, science communicators, and school and college students were also present in large number for the function.

In the Science@75 category the First Prize went to Secrets of Super Foods Makhana and Sabudana (Directed by Asrar Shamsi; Produced by Vigyan Prasar); Second Prize went to Boond-boond se... (Every drop counts; Directed by Nandan Saxena and Kavita Bahl; Produced by Kavita Bahl). The Third Prize went to two films: Transforming India (Directed by M Mohammed Ghouse; Produced by Instructional Media Centre, MANUU, Hyderabad) and Recycling of Parali (Directed by Vishal Sethi; Produced by Creative Channel).

In the Science for Everyone category, the winner of the First Prize was Ankur (Directed and produced by Mohan Anandrao Dhuldhar); the Second Prize went to Naren-The Intuitive Scientist (Directed and produced by Abhijit Dasgupta); and the third prize was awarded to My Life as a Snail (Directed and produced by: Akash Rajput).

YEAR-LONG CELEBRATION OF BIRTH CENTENARIES OF INSPIRATIONAL INDIAN SCIENTISTS LAUNCHED ON NATIONAL MATHEMATICS DAY

On the occasion of National Mathematics Day on 22 December 2021 Hon'ble Vice President of India, Shri M. Venkaiah Naidu inaugurated the year-long celebration of birth centenaries of inspirational Indian scientists, organised by Vigyan Prasar. While addressing the audiences present for the function held at Vigyan Bhawan, New Delhi, he stressed on the need for better science communication in regional languages to reach out to people in their mother tongue and to inculcate a scientific temper among them.

ecting on the impact of technology like Artificial Intelligence on people's lives, Shri Naidu said that science discourse now must become more inclusive and democratic. He called upon the scientific community to take the advancements in their fields closer to the people, suggesting they have a scientific social responsibility or SSR, akin to corporate social responsibility.

National Mathematics Day is celebrated each year on 22 November, marking the birth anniversary of the legendary Indian mathematician, Srinivasa Ramanujan.

Recalling the contributions of Ramanujan, Shri Naidu emphasised that it is our duty to recognise the contributions of Indian scientists and mathematicians to nation-building. Shri Naidu paid tributes to the six scientists whose birth centenary Vigyan Prasar is celebrating–namely, Har Gobind Khorana, G.N. Ramachandran, Yelavarthy Nayudamma, Balasubramaniam Ramamurthi, G.S. Laddha and Rajeswari Chatterjee–who were all born in 1922. He said that even though they were not provided adequate freedom, respect, and space to conduct their scientific studies under the colonial rule, they showed indomitable spirit in their scientific endeavour.

The Vice President called for introspection in the field of STEM (Science, Engineering, Technology, and Mathematics) and suggested that India must aim to become a Vishwa Guru, world leader in scientific research.

Stressing on the importance of right talent in STEM, Shri Naidu noted that the issue of gender divide in the field has to be addressed. He observed that even though the STEM field has more than 42 per cent female graduates, only 16.6% women researchers are directly engaged in R&D activities. He called for creating an enabling environment so that more girls can take up careers in mathematics and science.

Principal Scientific Adviser, GoI, Prof. K. VijayRaghavan; Secretary, Department of Science & Technology, Dr Srivari Chanderasekhar; Former Secretary of DST Dr T. Ramasami; Director, Vigyan Prasar, Dr Nakul Parashar and many other eminent scientists and technocrats were present during the event.

Six Vigyan Prasar publications: Sur Bhautiki and Laut aao Nino in Hindi; Journey into Mathematics and Demystifying the Nature in English; and Gacher Satkahon and Sotoborshe Bharatiyo Animation in Bangla and nine periodicals of Vigyan Prasar's in regional languages were also released in this occasion.

The programme also featured a technical session where experts from different fields remembered the life and works of the six scientists whose birth centenaries are being celebrated this year. Prof. Ch Mohan Rao outlined how Prof. H.G. Khorana played a crucial role in deciphering the genetic code and how he rose from a humble beginning to one of the greatest scientists of the 20th century. Prof. Rohini Godbole spoke as to how besides being an excellent academic and scientist, Prof. Rajeswari Chatterjee worked on social programmes with the Indian Association for Women's Studies promoting the education of women in the field of science and technology. Prof M.M. Sharma remembered the contributions of Prof. G.S. Laddha in the establishment of several chemical industries in the country.

Dr S. Ramasami recalled how Dr Yelavarthy Nayudamma was committed to social inclusiveness and worked to synergise research laboratories for the betterment of the underprivileged. Prof. P. Balaram recalled the contribution of Prof. G.N. Ramachandran to the triple helical structure of collagen and noted that he chose to work in India despite many offers of research assignments in western countries. Prof. Sudha Seshayyan highlighted the contribution of Prof. B. Ramamurthy towards the setting up of the National Brain Centre at Manesar as an apex body for the coordination of brain research in the country.