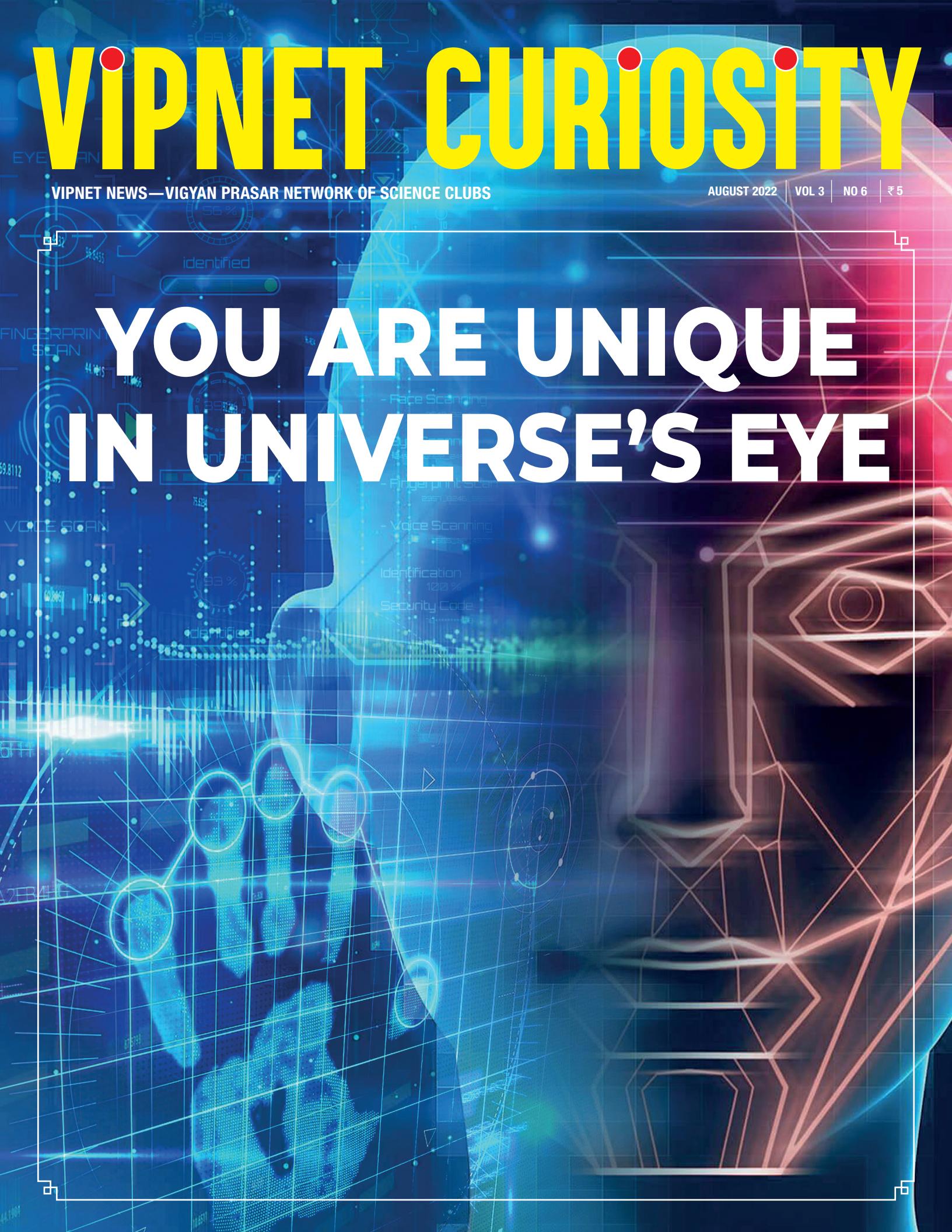


# VIPNET CURIOSITY

VIPNET NEWS—VIGYAN PRASAR NETWORK OF SCIENCE CLUBS

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## YOU ARE UNIQUE IN UNIVERSE'S EYE



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**EDITORIAL****K.B. Bhushan**

# Safety Precautions during Rainy Season



onsoon season promises of rain, new beginning and an escape from heat and humidity. However, it's not just humans who enjoy the rainy season but plants, animal, bacteria and viruses that enjoy it as much as humans. Monsoon is the best season for viruses and bacteria. Besides refreshing rain, this heavy rain provides a breeding platform for mosquitoes which can lead to micro-borne diseases. Malaria, chikungunya, dengue and flu are some diseases that cause life-threatening problems to humans. Similarly, the air particle has more bacteria in this time which result in mainly air-borne disease during this time. Stagnant water results in mosquito breeding during raining season. In order, to keep them out cleanliness in house and use of mosquito repellent is required. It is advisable to ensure you keep your gut flora happy. Having sufficient probiotics like curd, yogurt etc makes your gut stronger that ensure healthy level of good gut bacteria. Avoiding stale food during monsoon season is must as it may attract infection-causing germs. Please, include fresh vegetables in your diet to get lot of protein, fibre and other nutrients. Loading up on probiotics and fresh vegetables is the best option to maintain your gut strong during the rainy season. The month of august is going to be exciting, so enjoy the rain and witness the nature beauty.

We are in the second half of the year 2022. It's good to hear that many club members have registered. Not only this, many of our club members are

doing a marvellous job. The activities they plan and report they send prove their commitment of taking science to masses and building scientific temper among the people. I urge all science clubs to inspire other upcoming science club by adapting novel learning methods and upgrading skills.

The regular column of VIPNET-Curiosity is not only attracting club members, but it is also creating awareness among the students and children. This time curiosity brings yet another knowledgeable issue that will highlighting Fergusson College's unique feature. Another article is focuses on bullet train-based technologies and brings information about the short history of bullet train. This time the readers will witness the facts and benefits of a bullet train. The current issue has interesting poems for children and a special article on "You are unique in universe eye". We urge our club members to a conduct variety of activities and workshops.

So, keep reading, keep writing and keep enjoying the monsoon season with safety precaution !!!

Dr. K.B. Bhushan is Scientist E and a national co-ordinator of Vigyan Prasar Network of Science Clubs.

Email: bhushan@vigyanprasar.gov.in

# You are Unique in Universe's Eye

Astha Sachdeva

**Y**es, you are. Your body has such unique features make you stand out in a crowd of billions of your comrades from your species, with the highest brain capacity, THE HOMO SAPIENS.

## Fingerprints

These are not just random physical patterns. It's your gene that make it unique. Not that your genetic code while being in the mother's womb decides the complete pattern, but this womb decides the complete pattern, but your genes play a role in deciding the factors behind the formation of these fingerprints.

Two identical twins might be born from the same egg and sperm, sharing the same DNA, will still have unique fingerprints. During the initial stages after fertilization, foetus have volar pads and not fingerprints. Fingerprints start emerging around 10-15 weeks of pregnancy. It all depends on when the new ridges start appearing, the new fingerprint patterns grow into whorls if the volar pads are prominent, and if these pads are less exposed loop patterns emerge.

Scientists call fingerprints 'dermatoglyphics', and the study of fingerprints is called Dermatoglyphics.

You are not the only one blessed with fingerprints, and koalas have them too. We still fall in for the mystery of why koalas have prints, but they do.

Some rare beings are born without prints yes, there are rare genetic

conditions that prevent fingerprints and all the other ridged patterns.

## Take Drugs, your prints can get you caught

Intelligent fingerprinting, a company associated with the University of East Anglia, has created a drug test based on fingerprints. Their technology has the potential to detect a large number of



drugs, including cocaine, cannabis, and opiates. All of this from just one fingerprint, it isn't time-consuming, involves a non-invasive method unlike saliva or urine, and works even on dead bodies.

## So, your prints will not leave you even if you die, your identity card for this life and beyond.

Fingerprints but not on your fingers anymore. Our body is covered with ridges and irregularities that make it uniquely patterned. These patterns can help in confirming individuality. We are moving beyond fingerprints for biometric identification.

## Wobbly ears, time to fear – Only if you have committed a crime

Ear lobes have unique bumps, ridges, and distinct shapes, making it one of the most futuristic approaches to identification. In a study conducted by the University of Southampton, it has been shown that ear lobe identification has 99.6 % accuracy as scanned using computer software. This software recreated

positions, scales, and rotations of ear lobe ridge prints with utmost accuracy like the fingerprints. Due to gravity ear lobes sag with time but that easily be figured. So, it is challenging to disguise an earprint unless you get into a fight with Mike Tyson and damage the delicate body organ. The shape of your ear matters a lot; women tend to have smaller ears than their male counterparts, but you eventually can't hide it completely.

## Eyes are a way to your heart and the crimes you commit too

The muscle that constantly closes and opens with the amount of light entering your eye is your IRIS. We can easily see small patterns, some weird





arrays when we look deep into the eye. These weird patterns are what make you unique. Even your left and right iris have different patterns and thus iris is one of those strongest identity features which can hardly have errors. There is a genetic condition, 'Genetic Morphogenesis', which means that the iris develops its rifts, furrows, and pits randomly while fetal development occur. As a fetus opens and closes its eyes, these evolving features tighten and fold and these patterns emerge in the iris. Irises are protected by the cornea thus they do not change but are known to degrade with age and the use of contact lenses.

#### Your photos can also be used to extract the iris

This Afghan woman, Sharbat Gula was photographed for the first time in 1984 when she was just 12 years of age. Found by Steve McCurry, who was a photographer with National geographic, working on a project in refugee camps of Pakistan. Again, 2002, her image was taken and Curry eventually started investigating. He computed iris codes and matched both the codes 1984 and 2002. This iconic picture of an Afghan woman was already a symbol of war but later on became one of the break-

throughs just because someone decided to take the photographs seriously.

#### It's all in how you walk

Your gait, how you walk, and how you place your foot forwards say a lot about you. It can get you caught if you happen to involve in a crime scene. Compared to the other two, gait doesn't need to be observed closely. It can be done from a considerable distance.

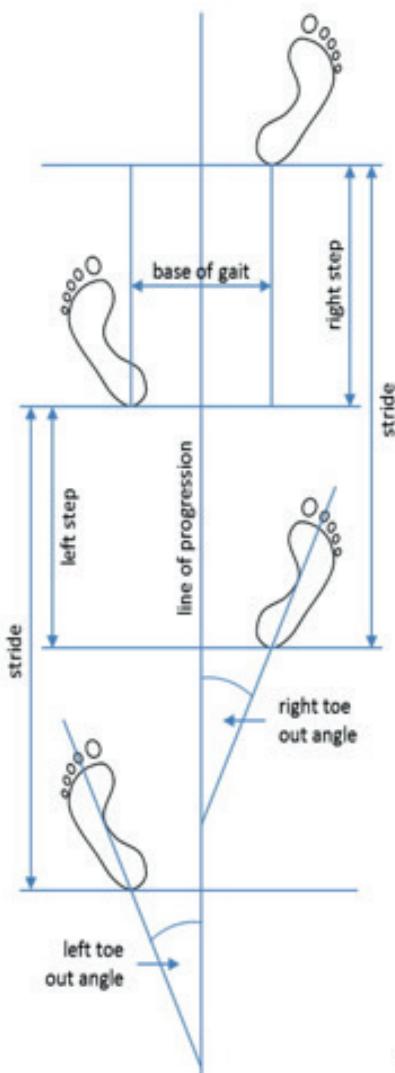
#### Ever thought of how you walk as unique too?

It is a systematic study of locomotion in humans, gait analysis can provide some critical insight for the investigation. This method is for correlating the patterns found at the crime scene. So, you have to walk a little more cautiously now, if you have criminal intent. From using gait analysis for medical health examination to realizing its importance as a biometric, we have come a long way in using it as corroboration to other pieces of evidence.

As we are spoofing a lot to covert the evidence, how long will you walk in disguise?

#### Scrap your tongue because it can break your disguise too

Anyone stuck out their tongue at you, teased you? Past is a bygone, go have a closer look the next time it happens. We all have unique tongue prints, the top of our tongue has uniquely designed shapes and ridges, and its textural physiology can be a



possible way towards identification and verification. Who knows, you got to stick your tongue out for a scan at the airport. The most important reason these prints are unique is that they cannot be mimicked, and you can't take someone's print without consent or even when the person is unconscious. So, the only organ used for biometrics that is housed inside a human body is the only invasive yet one of the most reliable ways to identify a person.

### **Not just the tongue, your whole mouth can spill the secret out.**

The sound of your unique voice, your teeth set, dental records, it's all that is different and unique about you. Our vocal tracks can be a completely different way of identifying a person. Have you ever clenched, ground, or just sucked your thumb while you were a kid? All these actions lead to variably unique teeth patterns.

### **Talk to my hand**

This method likewise relies on identifying distinctive vein patterns. However, as more reference points are used than in the case of finger vein pattern recognition, this is an even simpler and more secure identification method.

Along with iris scanning, the technology is now regarded as the finest available method field of biometric security because it cannot be copied (or only very difficultly). Palm scanning is quick, precise, and provides the user with a high level of convenience. Though the



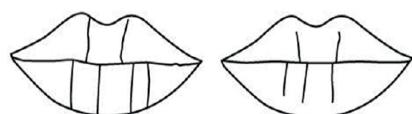
technique is quite expensive, these cannot yet be brought into the general public service. Primarily used in the banking sector and justice system.

Don't confuse it with hand geometry, as it is far more outstandingly scientific and logical than the outdated form of biometric recognition. Hand geometry uses fewer unique points to characterize an individual.

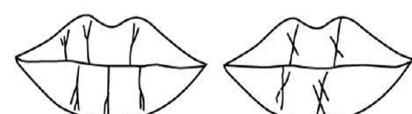
Palm prints are a future of safe invasion into highly secure systems and a genuinely authentic yet unique way of identification.

### **Lips don't lie, either**

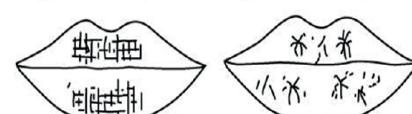
How you speak that makes you distinct and can get you in trouble. Since there are times when we use dental prints, fingerprints, and DNA, lip prints come in handy in cases of sexual assault.



Type I: Complete straight grooves. Type II: Partial straight grooves.



Type III: Branched grooves. Type IV: Intersected grooves.



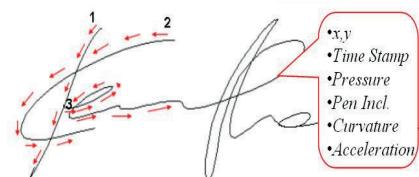
Type V: Reticular grooves. Type VI: Undifferentiated grooves.

Lips are groovy and have lines in them, making their prints to be unique and distinct. Individual identification and authentication can be done using lip prints as well. The technique of identification using lip prints is known as "Cheiloscopy". These prints are similar to that fingerprints. These prints don't just act as physical evidence but also as biological evidence as we can extract DNA from the lip impression and it is admissible in a court of law.

### **Your signature plays a role too**

One of the least trustworthy biometric verification techniques is the use of signatures. Although signatures can be copied and altered, they are nevertheless valuable as an additional degree of authentication.

The subjectivity and imprecision of handwriting analysis are primarily to blame for the "Zodiac Killer" case's un-



satisfactory conclusion. Throughout the 1960s and the beginning of the 1970s, the self-described "Zodiac Killer" wrote letters to the Federal Bureau of Investigation. Due to a lack of handwriting analysis technology, these letters could never successfully identify the murderer.

When a signature attempt does not match an existing record, identity fraud can be detected through signature analysis. As a result, rather than serving as a quick means of verification, it exists primarily as a forensic instrument.

### **Conclusion**

Biometric verification is one of the major investigation boons for the court of law. Fingerprints being the oldest in ancient China, thumbprints were utilized as distinctive identifiers on clay seals. Biometric verification advanced with the development of digital databases and the digitization of analogue data. Identification is now possible practically immediately thanks to new technologies.

### **Working on a biometric verification system**

The authentication method for biometric data is largely consistent.

First, a database is created and kept with a copy of the individual's distinctive characteristics, such as the voice-

print of someone who wants access to bank account information. ID verification is necessary when the person returns to the bank to inquire about their account. At that point, voice authentication parameters are used to compare the newly captured record to the one that has been stored. The person's identity is verified if the new voice print record corresponds to the one in the database.

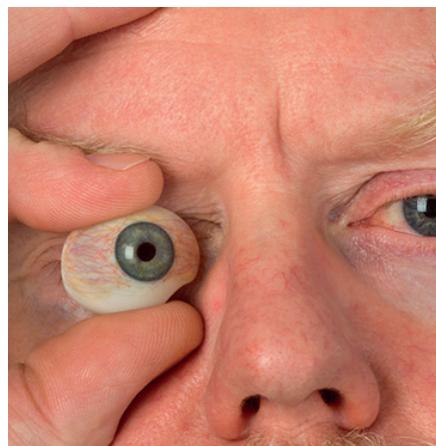
Biometric data is frequently made more portable and accessible using cloud technology. Agencies and organizations may perform biometric identi-

and leaving the criminal justice system, law enforcement organizations employ biometric IDs including fingerprints, iris scans, facial recognition, and facial recognition.

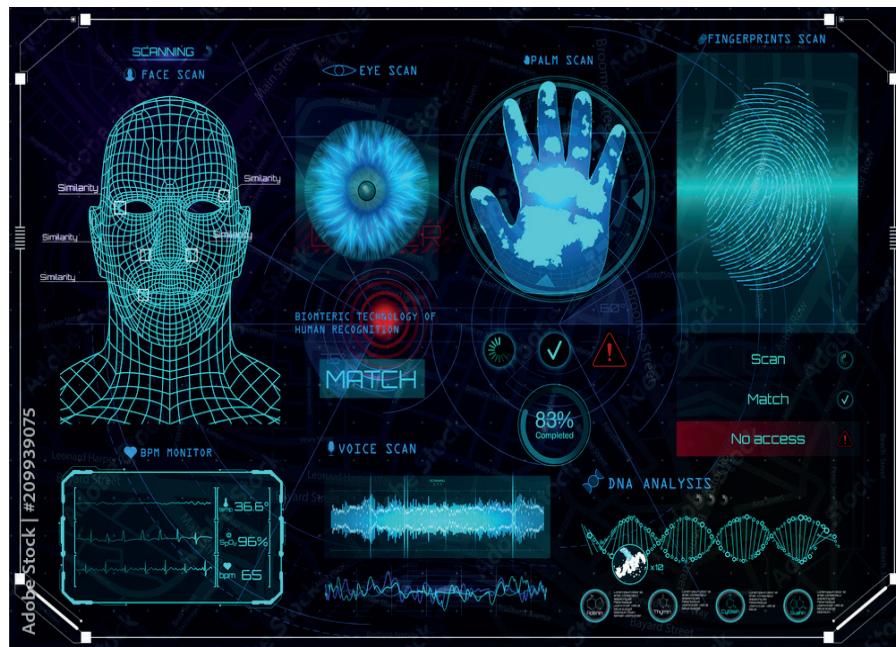
Other governmental organizations are investigating the use of biometric identification for voter registration and passports.

### Challenges for biometric analysis

Hackers can use your biometrics and use it against you. Hackers have developed techniques to get around biometric



a non-live image from a video or photo to fool a facial biometric algorithm.



fication on any person, wherever they are, thanks to cloud-based technology.

### Where can these biometric verification techniques

People are identified through biometric verification in a variety of contexts, such as the following:

Financial institutions use speech recognition technology and other biometrics to identify phone calls

Biometrics are proving to be a trustworthy method of patient identification for healthcare professionals.

To monitor individuals entering

authentication, even stealing fingerprints. When they succeed, they have access to your most private and vulnerable data. This includes your SSN, date of birth, and other information that can be exploited for identity fraud, as well as digital wallets and bank accounts.

### Your biometric can be spoofed

One kind of presentation attack is spoofing. A fraudster may use spoofing attacks to assume someone else's identity to get around a biometric identification system. For instance, they might try to impersonate a targeted victim using

### How biometrics is reshaping the identification

Online identity verification is changing due to growing popularity of biometrics as a very effective security precaution. Document verification and biometric authentication services are used to address the problem of trust between service providers and their customers in the lack of universal digital identities that can be utilized across services and cross-border digital identities.

You can't avoid being caught, and you will always leave a print behind; you will move on and will still leave a trail in the past, be cautious of where you leave it and mind it, leave a good one.

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# Bullet Train: High Speed Railway Transit Technologies in India

Shashank Patel

In the course of upbringing of Generation Z (born 1996-2010), every childhood witnessed a story of Bullet Train and its flying speed in India. Several kids learning programs and kindergarten songs includes the story of Bullet Train as a symbol of growth and development. It is a dream for many of us to once board this majestic mode of transport which is comfortable, most safest, and environment friendly.

## Short History

The original name of Bullet Train is 'Shinkansen', which was given by its innovator country Japan. Hideo Shima (1901-1998) was a Japanese engineer and the driving force behind the building of the first bullet train in Japan. The concept behind this invention was to develop a high-speed world class intercity train network for efficient public transportation system. Japan achieved highly advanced technological accomplishment in 1964 by revealing its first variant, 'Tokaido Shinkansen', just before the Tokyo Olympics. The Japanese adopted it so fast that in only three years of its debut run, it serviced 100 million passengers. Currently, the fastest bullet train operating in Japan is the Nozomi (Shin-Osaka to Hakata route), with an average speed of ~300 km/h.

## Domestic High Speed Railway Transit Technologies

Indian Railways has one of the biggest railway networks in the world.



Series E5 Bullet Train, to run on Mumbai-Ahmedabad route.

In their arsenal, there are some noted names who are cloaking the speed above 150 km/h nowadays. Everyone knows about the Shatabdi Express (150 km/h) but there are two more – Vande Bharat Express (180 km/h) and Gatimaan Express (160 km/h). These trains in India are fastest, running with great efficacy & safety standards. But with the need of more advanced and time saving rapid transit mode of transport, Indian government signed Memorandum of Understanding with Japanese government in 2016 to implement first bullet train project in India named as Mumbai-Ahmedabad High Speed Rail Corridor (MAHSR, 508 km). Its foundation stone was laid by Indian Prime Minister Narendra Modi and the then Japanese Prime Minister Shinzo Abe in 2017. Under 'Make in India' policy, Ja-

pan provided its technological-cum-financial support at minimal interest rates for developing these projects. The responsibility of this mega project is on the shoulders of National High Speed Rail Corporation Limited (NHSRCL) which will act as a sole agency to work on all related projects in future.

## Indian Bullet Train

Indian railways under the National Rail Plan (NRP) envision enhancing the outreach of High-Speed Rail (HSR) system and increasing connectivity to all the cities of importance. NHSRCL identified seven more HSR corridors for which the detailed project reports are in preparatory. By 2026, the Mumbai-Ahmedabad High-Speed Rail Corridor (MAHSR) will be operational. This will not only be a passenger



line but the MAHSR route will also be used as a transit hub where people can interchange between multiple modes of transport. The others identified routes mentioned below are in different planning stages:

1. Delhi-Varanasi: 865 kms
2. Delhi-Ahmedabad: 886 kms
3. Varanasi-Howrah Route 760 kms
4. Mumbai-Nagpur: 753 kms

5. Mumbai-Pune-Hyderabad: 711 kms
6. Chennai-Bengaluru-Mysuru: 435 kms
7. Delhi-Amritsar: 459 kms

#### Benefits

From people perspective, high speed trains are a more easily accessible mode of commute compared to air travel. Also, it will be more viable and cost ef-

fective for the developing countries like India. Bullet Trains played a vital role in achieving regional integration worldwide and creating socio-economical balance in societies. Bullet Trains supports growing inter-urbanisation needs for much stronger connectivity among the key towns. The proposed routes are major financial hubs, busy city centres, and heritage cities which are preferred destinations by this mode of travel.

Bullet trains will connect India's economically vital regions by making them more productive, mobile, and internationally competitive. This advanced technology of Bullet train will sum India's technical prowess by transfer of technology and skill development of domestic manpower. The people working in these projects getting their trainings in Japan and are using their upgraded skills to reduce unemployment, raising incomes, and improving overall living standards.

It is calculated that generation of carbon emissions over the world's HSRs is one-third compared to car travel and a one-fourth compared to air travel. This makes Bullet train more eco-friendly mode of travel which helps to reduce country's carbon footprint which is critical to achieving Sustainable Development Goals (SDGs). Specifically, in the case of India, Bullet trains will facilitate the shift of passengers from air and road between major cities. This shift will positively impact the environment as a whole by reducing green house gases and improving air quality.

Shinkansen technology on which Indian Bullet trains will run offers the highest safety levels in the world. Since its invention (1964), it had a track record of zero casualties and running at impeccable average punctuality levels of 40 seconds in delay. It means India will find the most trustable and reliable mode of transport in the form of Bullet Train.

It will be the most comfortable

## Interesting facts about Shinkansen (Bullet Train)

1. Its popularity due to the trustworthiness is so high that a movie named 'Bullet Train' was made and just going to release in next month (August, 2022) starring biggest names of Hollywood like Brad Pitt, Sandra Bullock, Joey King and others.
2. For utmost safety, elevated bridge structures of Bullet trains will use steel structures against concrete girders known as Viaduct. Viaduct structures connect two points of roughly same elevation through a series of arches, piers and columns allowing direct overpass across rivers, valleys etc.
3. It is the most eco-friendly mode of transport in the world. The new advanced series N700S model used in Japan operated at 28% less energy than models of 1992. Although bullet trains may not travel as fast as planes but they only consume 12.5% of the energy planes require and produce about 92% less carbon emissions per seat.
4. In Japan, eating in trains typically not recommended but in Bullet Train, it is best culinary experience. A special railway food named 'Ekiben Bentō' box is the must eat experience among the passengers in Japan.
5. As Japan is very anime loving country, their Bullet Trains also have several themes. Hello Kitty & Doctor Yellow are most loving trains there.
6. In developing and uplifting the speed of Bullet trains, Japan achieved the successful operational speed of 603 km/h for its Maglev trains. Maglev are the next generation bullet trains under development in Japan, who are the fastest ever trains worldwide. It will be operational between Tokyo & Nagoya by the year 2027.
7. When bullet trains exit a tunnel, a sonic boom is created, which is too dangerous for the ears. This sonic boom is so powerful that it can blow a freight train over. To overcome this tunnel boom, Japanese government install tunnel extensions to help quiet things down.
8. Bullet trains have an average stop time at a station of 50 seconds.
9. Amazing thing is that even at this speed, Bullet trains don't have an automatic driving system; drivers still make them run manually. The only automation it has is its high-speed prevention system to ensure limitation on its top speed.



So that's why Bullet trains are recognised worldwide for their safest operations & highly trustworthy among the other mode of transport available. India will surely experience; a luxurious, punctual and environment-friendly mode of transportation under the ambit of Indian Railways. This technological prowess will secure a spot of India on the global technology map. This state-of-the-art technology & its component will boost the domestic acumen of Indians to standardise our own domestic railway system at international standards. The Future of India is bright; Bullet train technology will boost its pace to achieve it.

railway travel for passengers as it is noiseless, pressure controlled, vibration free, spacious, fitted with modern toilets, exclusive baggage space and Wi-Fi enabled trains. Digital display consoles, audio announcement system, and on-board assistance makes it more useful for elders and specially-abled persons.

Another milestone that Bullet trains achieved is that they are safe against natural disasters; its power failure detection braking system stops it in case of earthquakes through emergency braking. The Automatic system halts train within 80 seconds seven if it is functioning over a speed of 300km/h. A Network of sensors continuously monitors track temperature, rains, and crosswinds by sending an alarm signal to an operational control centre.

Likewise, all the developed countries have, Bullet trains that will not have any droppage on the tracks along the way. The sewage and waste generated on the train in toilets or otherwise will be stored in large waste retention tanks which makes it more hygienic and environment friendly.

All the Bullet train stations will be built on the idea of 'green building'. It means they will have a sustainable design, water-efficient fixtures, green-pro products for construction, energy-efficient light fittings and all other components make ecologically sensitive. These all buildings have integrated solar capacities and are provided with roofs to reduce energy consumption. Rainwater harvesting and water rejuvenation pits are vital design elements for buildings going to be constructed.

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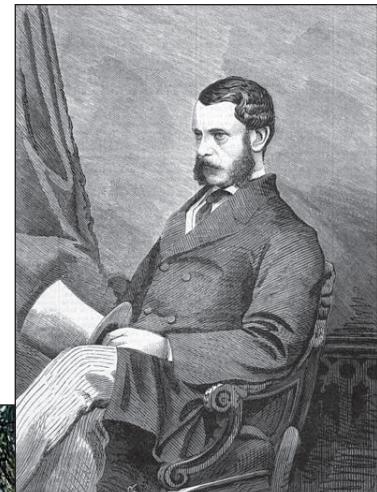
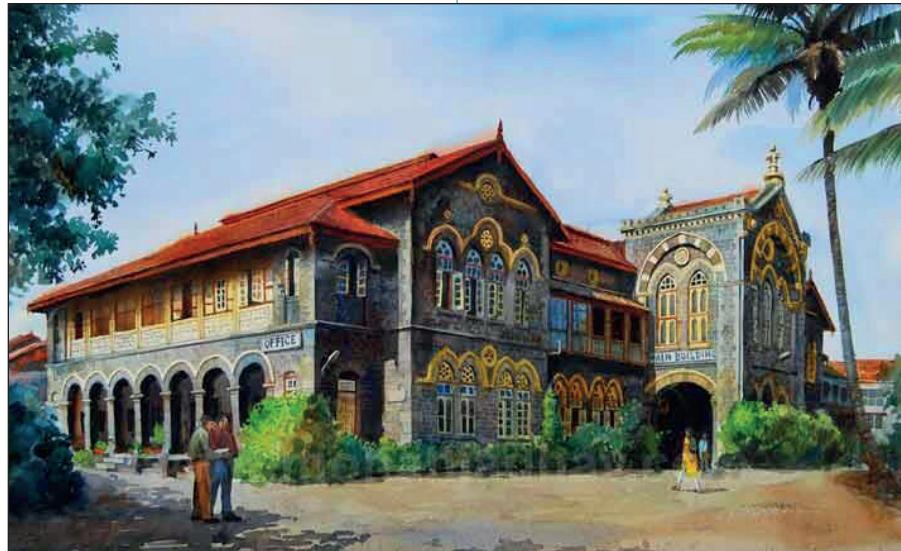
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*com*

# Fergusson College - A Stellar Legacy

Sunila Athley

**N**estled in the picturesque city of Pune on the foothills of Sahyadri mountains is the 137 years old Fergusson College, named after the former Governor of erstwhile Bombay, Sir James Fergusson. Stonewalled buildings dot the 65-acre campus. The college is surrounded by hillock, 'Fergie Hill' fondly called by its students or 'Tekdi' in the local language and to the other is the bustling hub, Deccan Gymkhana with a a quaint combination of 100 years old residential bungalows, numerous bisecting lanes and bylanes lined with tall shady trees. Swanky eateries visited



Sir James Fergusson

by the staff and students include the ubiquitous Udupi restaurants and the Irani café, where *bun maska* and *chai* is still rule the menu chart

From its inception in 1895, the college has a with India's freedom struggle and reformist movement, giving it a unique charm and legacy. It is no bit surprise that Government

of India designated it a heritage site in 2015. The college's rise and fame are partly related to its association with eminent academicians, scholars, scientists, revolutionaries, social reformers, industrialists, media people its, researchers, politicians, sports persons who have been its alumni, thus giving the institution respect and



reverence it so rightly deserves. It also has the unique distinction of giving the country two Prime Ministers.

During the colonial era, the British Colonial Government crushingly suppressed the Indian Rebellion of 1857. An ardent need was felt to bring our diverse country together, and for that, change in peoples' mindsets through peaceful transformation was required. Reforms in our indigenous education system were one of the solutions to bring our diverse country together and for that change in people's mindsets was required. This was the topic of hot discussion in hushed meetings of firebrand nationalists like Bal Gangadhar Tilak, Vaman Apte, Mahadeo



Namjoshi, Gopal Ganesh Agarkar and Vishnushastri Chiplunkar. Although founded by Indians, the college received support from British statesmen such as Lord Rippon, Sir Willian Wedderburn and the Principal of Elphinstone College, Bombay, William Wordsworth, the grandson of the famous poet.

Fergusson College was the genesis for the cultural and intellectual renaissance. It was established at a time when institutions for higher education were inadequate in the country. It made best use of the western system under Indian condition. Gandhiji referred to the college as a role model for other colleges. In his speech during the Golden Jubilee function in January 1935, Nobel laureate Sir CV Raman said "*History has been written in Poona, history of self-reliance and constructive national effort.*" In a letter



The N. M. Wadia Amphitheatre

to celebrate its Diamond Jubilee, Pt. Jawaharlal Nehru complimented the institution's ideal selfless service and of preparing true citizens of free India.

The amphitheatre, envisioned by Wrangler RP Paranjpye, the first Principal of 20<sup>th</sup> century, was inaugurated in 1912. Its semi Gothic-style architecture and imposing height give it a unique and awe-inspiring splendour. It was the venue for the first All India Women's Conference in 1927 as well as the Children's Science Movement in 2001 by Prof. Raghunath



Library of Fergusson College, with a marble bust of Lokmanya Tilak

Mashelkar, Director General, CSIR. Notable speakers like Lala Lajpat Rai, Sir J C Bose, Rabindranath Tagore, Sir PC Ray, Acharya Kalekar, Sir CV Raman, Prof. Fowler and Pt. Madan Mohan Malviya have addressed gatherings from its dais and inspired generations of students.

The College also have main library named Bai Jerbai Wadia library. This library was completed in 1929 which comprises of two storey building that can accommodate 400 students at a time. Home to rare collections and manuscripts, the library is funded by the National Archives of India to digitize them for posterity. It is named in the loving memory of the mother of industrialists, Sir Cusrow Wadia and Sir Ness Wadia.

The college also has the honour of having the first commemorative stamp in its honour to celebrate its centenary in 1985. The First Day Cover depicts the four founders and stalwarts who envisioned of the institution as a centre of liberal learning.

*Ms. Sunila Athley is an alumnus of Fergusson College, Pune.  
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# Symmetry-A Foundational Concept in Physics

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s commonly understood, symmetry means harmony or balance. It also signifies beauty (regularity) and unity.

That has been the notion of symmetry right from the outset. Symmetry can be seen in flowers, in butterflies, and so on. From engineering and architectural point of view, symmetry can be seen in the design of buildings. It manifests in myriad man-made art, drawings and patterns. It is easy to understand what visual or geometrical symmetry is. Think of a circle, a square, a triangle or a rectangle. Now, if you hold one of these forms down the middle, each side will be the same size and shape as opposite side. This is referred to as bilateral symmetry. We can even find symmetry in circular designs. When an object is rotated around a circle in equidistant increments, it leads to radial symmetry. In other words, when something is rotated around a circle to form a symmetrical design it possesses radial symmetry. The face, as well as the rest of the human body, is (usually) symmetrical as well. If you have a line drawn in the middle of a typical human face, you will find that if you can fold that image, the eyes will line up well as the ears, both halves of the man and the mouth. Physicists and mathematicians, however, define the term symmetry in a more precise manner. They say that symmetry of a particular kind exists when a specific operation leaves something unchanged. In simple terms, something is symmetrical if one or more of its aspects are indifferent to a change under a certain operation. In other words, scientists view symmetries

as changes that don't really change anything, differences that don't make a difference and variations that leave deep relationships invariant. For example, a rubber ball can be turned freely and, its appearance won't be altered. A physicist, therefore, might say the ball is "symmetrical with respect to rotation."

From a physicist's point of view, space and time have certain symmetries. The laws of physics are the same whether you are in India, Germany, the moon or the bottom of the ocean. Time also has a kind of symmetry, according to which no particular instant in time is inherently different from any other. In other words, physics is the same whether it is yesterday or tomorrow, a thousand years ago or a few weeks later. As symmetry signifies something which is "indifferent to a change", or something which remains unchanged (invariant), symmetries of space and time have, in technical jargon, been referred to as "translational invariance" and "time translational invariance", respectively.

In classical mechanics, symmetry was found to exist between the state of rest and the state of uniform motion (with constant velocities that do not change). This kind of symmetry is known as Galilean invariance after Galileo Galilei, from whose work it is derived. Imagine you are a passenger in an automobile and you are sipping a cup of tea. The simple fact that the tea stays in the cup when you are moving along at a steady speed, just as it does when you are stopped, it means that the behavior of the physical laws does not depend on the velocity of the system to which they are applied. Strictly speaking, this

is only true when the velocities are constant, as shown by the fact that the tea tends to slop out when you accelerate out of a stop light or break to a halt.

Einstein gave his special theory of relativity in 1905. The cornerstone of his theory is that speed of light in a vacuum is constant. Speed of light is special; your laser beam won't advance any faster just because it is shot from a speeding satellite. Therefore, distance and time measurement must change instead depending on one's state of motion, leading to the effects known as "length contraction" and "time dilation."

Einstein proposed in his special relativity that the behavior of some physical properties, such as mass and length depend on the velocity of the system to which they are applied. However, the special effects produced by relativity show up at enormous velocities. Since the equations explaining "length contraction" and "time dilation" were developed by Hendrik Lorentz, the new kind of symmetry is called Lorentz invariance. A consequence of length contraction is that moving rods appear to be shortened in the direction of motion, while the time dilation means moving clocks appear to run slow.

In 1915, Einstein propounded his general theory of relativity; namely, that gravity is the result of the space-time curvature. However, a serious problem arose when it was discovered that energy might not be conserved in strongly curved space-time. It was well known that certain quantities in nature must always be conserved: the amount of energy, the amount of electric charge, the amount of momentum. The German

mathematician Emmy Noether played a significant role in resolving the issue. She showed that symmetries of general relativity - its invariance under transformations between different reference frames – ensure that energy is always conserved. Einstein's theory of general relativity was, therefore, saved.

Noether came up with a theorem that bears her name, demonstrating that wherever there is symmetry in nature, there is also a conservation law and vice versa. In other words, the symmetries of space and time are not only linked with the conservation of energy, momentum and angular momentum, but each implies the other. Noether's theorem demonstrated, that conservation of law are necessary consequences of symmetries, and symmetries necessarily entail conservation laws.

We now discuss some other related symmetries. One of them is charge symmetry. Simply put, it is a statement about solid nuclear force: nuclear force between two neutrons is the same as the nuclear force between two protons. Then, there is symmetry, called charge independence, which is more considerable than charge symmetry; it has a broader ambit. According to this symmetry, the nuclear force between any two nucleons (be that protons, neutrons, or a combination) is the same apart from the electroweak - unification of electromagnetic and weak nuclear forces - contribution. The ideas of charge symmetry and charge independence in nuclear physics led to the intricate concept of isospin, which is an abstract way of describing the symmetry between neutrons and protons.

Three different symmetries, namely, mirror symmetry, charge conjugation symmetry and time-reversal symmetry, have also been introduced by physicists. In mirror symmetry, all events should occur exactly the same way, whether they are seen directly or in a mirror. Thus, mirror symmetry trans-

fers everything into its mirror image, implying that the left becomes right, and vice versa. In the language of physics, mirror symmetry is called P-symmetry (P stands for parity). Charge conjugation symmetry states that particles should behave like their antiparticles, which have exactly the same properties but the opposite charge. In other words, it transfers a particle into its antiparticle, or vice versa, called C-symmetry. Time-reversal symmetry (process evolving in reverse) means that nature does not favour a particular direction of time. It is called T-symmetry.

Wolfgang Pauli, Julian Schwinger and the German physicist Gerhart Luders derived the CPT theorem in the 1950s. This theorem states that particle interactions are symmetrical under parity, or mirror (P) symmetry as well as charge conjugation (C) and time-reversal (T) symmetries. While most of nature seems to follow all the three, namely, C-, P- and T-symmetries, the weak force follows neither C- nor P-symmetry (although it follows T-symmetry). Physicists have, therefore, come up with the idea of CP symmetry - a combination of C- and P-symmetries. Weak force follows CP symmetry. Symmetry principles in physics have led to the discovery of new forces and particles, including W and Z bosons, quarks and gluons. Symmetry told physicists to look for both Higgs boson and gravitational waves - two momentous discoveries of the past decade.

“Hidden” or “broken” symmetries have also been studied by physicists. Three physicists – Makoto Kobayashi, Toshihide Maskawa and Yoichiro Nambu – were awarded the 2008 Nobel Prize in Physics for their works on the so-called broken symmetries. Symmetry breaking was essential to understand the very evolution of the universe with the Big Bang some 13.8 billion years ago. If, during Big Bang, matter and antimatter were created

in equal amounts, they should have annihilated each other, leaving not a trace of matter behind. Only a puff of energy would have been left. Yet we are here. The perfect symmetry that should have existed in the early hot moments of the universe somehow got destroyed as it cooled down, just as a pencil is standing on its tip loses the symmetry it possessed as it falls. Scientists are still studying what caused our universe to be matter-dominated. However, they surmise that breaking of CP symmetry called CP violation (the first instance of CP violation was observed in the decay of the elementary particle, called kaon, for which Nobel Prize in Physics was awarded to James Cronin and Val Fitch in 1980), could have caused this. It is also convincingly being argued by scientists that time-reversal symmetry breaking could be an essential ingredient for creating a universe that predominantly matters instead of an equal mixture of matter and antimatter. Another important consequence of symmetry breaking is the so-called Higgs’ mechanism. Physicists say that in the very early stages of the universe, the original symmetry between forces was destroyed, thanks to Higgs’ mechanism, which gave the individual particles their mass. However, be it symmetry making or symmetry breaking both have loose ends. For instance, symmetry-based reasoning predicted a slew of things that haven’t shown up in any experiments, including the “supersymmetric” particles that could have served as the universe’s dark matter and explained why gravity is so weak compared to the electromagnetic and the other forces.

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## Online Workshop

Aryabhatta Science Club (VP-KA0019) Karnataka, organised two online zoom webinars for students and teachers. The webinar was focused on the theme “Phonemes and phonics” and “Reading English using phonology”. Total of 120 participants attended both the webinars.



## International Day Against Drug Abuse

Chem-star science club (VP-MH0077), in association with BNN college, Maharashtra, organised the International day against drug abuse and illicit trafficking program. To create awareness among the masses various event like poster competition and rally was conducted. In total 35 club volunteers and eighteen students from different school participated. The event was conducted at BNN College and Dhanakar Naka road.



## Science Awareness Program

Kanithavaani club organised a science awareness webinar on the theme “Let's talk science twenty-six series”. The event was led and executed successfully under the guidance of Prof. Vijaykumar. The webinar main objective was to build scientific thoughts and explore scientific mechanisms. A total 25 participants actively participated with great enthusiasm.



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