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FERROFLUIDS

I was happy to read the article on ferrofluids by Dr T.V. Venkateswaran in the current issue of *Science Reporter*. It gives a good introduction to an emerging field. It has been written in reader-friendly language.

While the report on Sciencetoons was interesting, a few pictures of the cartoons prepared by students would have been nice. But the participants come from elite schools. When are we going to reach the poor village student?

Rajagopalan SS

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SIGHTS ON SPACE

THE editorial **Sights on Space** published in the February 2020 issue of *Science Reporter* was very informative and very interesting for everyone but more interesting for those who have a keen interest in space. The editorial tells about the very first Human Spaceflight Programme of India. When India successfully launches Gaganyaan in the year 2022, it will become the fourth nation to send a human to space after the nations like United States, Russia and China. All the best to the ISRO team for their upcoming missions.

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INFORMATIVE AND INTERESTING COVERAGE

THE most interesting topic of the January 2020 issue was the feature article **Mission Gaganyaan – India's Biggest Space Challenge**. India is going to be the fourth country to send humans into space. If everything goes as planned, it will mark the culmination of approximately 15 years of the relentless efforts of ISRO and also the 75th year of independence of India.

Segregating Waste at Source... was also a very important topic, as we face a dilemma regarding the segregation of dry and wet waste. The Swachh Bharat dream will come true only when we are able to dispose off the specified garbage in the scientifically specified manner. Recycling of waste is also an inevitable segment of waste management, and obviously, we should take care of it.

I would also like to congratulate the Editor for his outstanding and contemporary editorial **Food Choices Impact Personal & Environmental Health**. The poison our current generation is consuming in the name of fast food is absolutely unscientific and subsequently unhealthy too. Rigorous social awareness, as well as stringent rules, have to be incorporated to curb the issue of the slow food poisoning our society is facing.

In the column Spectrum, the report **New Dust Suction Tool can Help Prevent Silicosis** was encouraging to read. The invention of the smart stone dust precipitator will help to reduce pollution and contain Silicosis.

Pradip Chakraborty

Nainital, Uttarakhand

REACTIONS



Science REPORTER



CONTROLLING CORONA

THE short feature **Novel Coronavirus-2019** (*Science Reporter*, March 2020 issue) is worth reading. It gave information about the virus briefly and accurately. This is what is required. It was published at an appropriate time when media like WhatsApp have been propagating a lot of misinformation on Coronavirus. There is a corona scare everywhere in the world mostly because of lack of proper knowledge. *Science Reporter* deserves a pat on the back for publishing the feature on coronavirus. I hope the scientific community in India and CSIR, in particular, will take up the challenge of controlling the spread of coronavirus.

Ravindra Bhagwat

Kalyan, Mumbai

Attention Authors!

- Choose informative, interesting, creative and topical scientific subjects to write on.
- Avoid academic, specialised and technical subjects.
- Write in a popular style to make the article/write-up appealing for a wider readership.
- Provide original photographs wherever possible.
- Do not forget to mention your name, current affiliation, complete, correct postal address, and e-mail.



Science REPORTER

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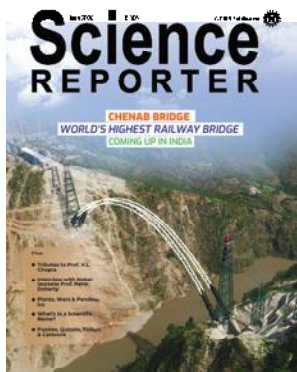
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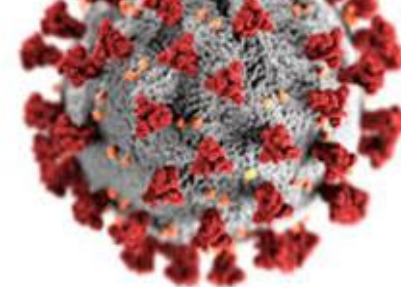
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Coronavirus Pandemic Innumerable Questions, Few Answers



www.cdc.gov/media/subtopic/images

VERY few of those living today would have experienced, ever in their lifetime, the trying conditions and circumstances thrown up by the Coronavirus outbreak. With much of the world under lockdown and infections and casualties due to COVID-19 piling up every day (at the last count more than 4.7 million infected and around 3,15,000 dead), the pandemic has completely changed the way we live and work. At the same time, the new virus has thrown up many unusual and intriguing questions...with very few answers.

Of course, some questions and beliefs have been born out of ignorance. There are many such beliefs in prevalence today. Will eating garlic prevent you from coronavirus infection (no it won't, but it helps improve immunity); will drinking bleach or absolute alcohol kill the virus inside your body (no it will not kill the virus, while bleach can cause you serious harm, absolute alcohol could even kill you); can thermal scanners detect coronavirus (no, they can detect fever but not the presence of virus), and many such others.

However, during the course of the pandemic, the intriguing nature of the new virus and an evolving understanding of its sinister workings over time have seen many answers to several questions getting modified or corrected. For instance, while initially it was believed that putting on masks had no benefits whatsoever, at a later point it emerged that masks could considerably check the spread of the virus among populations. Then, there are no clear answers to how long the lockdowns should be implemented. There is also not much clarity on why some places in the world are witnessing high fatalities while others are not.

There are also questions pertaining to immunity – will recovery from the first infection confer lasting immunity? How long would such an immunity sustain? Can one get infected a second time? Although there are reports of recovered COVID-19 patients testing positive again in China, South Korea and Japan questions are being asked about the accuracy of the tests.

Then, there are other equally intriguing questions being asked: How long a run will this virus enjoy? How soon is it expected to go away? Again, very few answers. Of course, much will depend on how soon we can come up with medicines and vaccines or how long it will take for the population to develop herd immunity – this happens when a high percentage of the people in a community become immune to an infectious disease which stops the disease from spreading. This, in turn, happens in two ways: when many people get infected and develop antibodies or when many people are vaccinated against the disease.

Finally, while all of us wish the virus to go away as soon as possible, another question that hangs above our heads is: Will we see more such epidemics? If yes, when will the next epidemic happen? Well, writing in *Time* magazine, Bryan Walsh in his article “The World Is Not Ready for the Next Pandemic” says, during the last 30 years, the number of annual epidemics has nearly tripled (<https://time.com/4766624/next-global-security/>). Several outbreaks of Zika, MERS-CoV, SARS, cholera, tuberculosis, HIV/AIDS, influenza and Ebola have killed hundreds of thousands of people. This is because the world has become increasingly connected, people are moving around the world at a much faster pace. At the same time, climate change is also increasing temperatures and expanding the habitats of disease-carrying species.

So, the next pandemic is only a matter of time. Perhaps we can choose to be better prepared the next time it strikes.

Hasan Jawaid Khan

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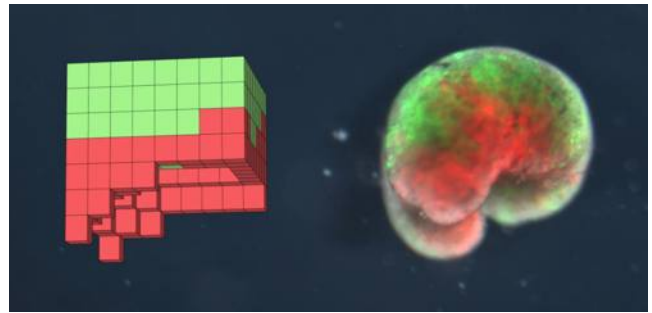
Xenobots: World's First Living, Self-healing Robots

RESearchers at the University of Vermont (UVM) and Tufts University, US, have created “Xenobot” – the world’s first living, self-healing robot from frog stem cells. These are tiny blobs of moving cells made from stem cells obtained from frog embryos. They are less than a millimetre in width facilitating them to travel inside the human body. Furthermore, they can walk and swim, can survive for weeks without food, and also work together in groups. Xenobots are named after the African clawed frog, *Xenopus laevis*.

Xenobots would prove useful for surgeries as they have holes that can be utilised to carry drugs or medicines to the body. They can perform other tasks too, like cleaning radioactive waste, collecting and degrading microplastic from the oceans. Xenobots can survive in an aqueous environment for several days or even weeks without nutrients.

The researchers took stem cells from the frog embryo and increased their numbers by incubating them. Next, the cells were cut and rejoined under a microscope into definite forms designed by artificial intelligence. These newly created forms are not found in nature. The skin cells bonded to develop a structure while the heart cells were able to work together and create motion. These cells also showed the ability to heal themselves after being cut.

According to a statement on the website of the University of Vermont (UVM), Joshua Bongard, a computer scientist and



robotics expert at the University of Vermont who co-led the new research says, “These are novel living machines. They’re neither a traditional robot nor a known species of animal. It’s a new class of artifact: a living, programmable organism.” The new creatures were designed on a supercomputer at UVM and then assembled and tested by biologists at Tufts University.

“We can imagine many useful applications of these living robots that other machines can’t do,” says co-leader Michael Levin who directs the Centre for Regenerative and Developmental Biology at Tufts, “like searching out nasty compounds or radioactive contamination, gathering microplastic in the oceans, travelling in arteries to scrape out plaque.”

The research was published in the *Proceedings of the National Academy of Sciences (PNAS)*.

Reference

Sam Kriegman, Douglas Blackiston, Michael Levin, and Josh Bongard. A scalable pipeline for designing reconfigurable organisms. *PNAS*, 2020 DOI: 10.1073/pnas.1910837117

Soft Materials Allow Scientists to Study Earthquakes in Lab

UNDER constant stress, certain soft materials reorganise themselves in a manner very similar to how the Earth’s crust is restructured during earthquakes, a new study by researchers at the Indian Institute of Science (IISc), Raman Research Institute (RRI) and ETH Zurich have found.

The team studied thin sheets of two types of soft materials — a tightly packed gel of soap-like molecules, and

a glass made from clay nanoparticles — sheared between two steel plates. When force was continuously applied by the plate on the material, the internal reorganization of the material generated burst-like patterns over time that resembled seismograph data generated by earthquakes.

“When you apply certain stress, the material is trying to adjust. Its shear rate is fluctuating. This fluctuation is similar to what is seen during earthquakes,” says Ajay Sood, DST Year of Science Chair Professor at the Department of Physics, IISc, and senior author of the paper published in *Nature Communications*.

Earthquakes typically occur due to friction between pieces of the Earth’s surface called tectonic plates, releasing a sudden burst of energy that causes severe damage to the environment and

human lives. Scientists still don’t know how to predict when an earthquake will strike next, or how strong it will be.

To simulate earthquakes in the lab, researchers usually apply force to rocks or ceramic materials and study how they deform and crack under stress. But because these are solids, it can be difficult to study changes that happen inside the materials before they split open.

“The main disadvantage with these previous experiments is that no one can probe the domain structure directly,” says Sayantan Majumdar, Associate Professor at RRI and one of the authors. “We cannot see what is going on inside the material.”

In the current study, the researchers used soft materials instead and observed how they reacted under stress. Using an optical microscope

Normal Body Temperature Declining

THE broad mark on the clinical thermometer indicates the average “normal” temperature of our body at 98.6° Fahrenheit. In fact, it varies from person to person depending upon sex, age and health status. Besides, it depends upon factors like time of the day (lowest in the morning, lower during the day and higher at night), the location of the body in which the measurement is taken (mouth, under the armpit, etc.), subject’s state of consciousness (waking, sleeping or sedated) and emotional state (anger, depression, etc.). Physical exercises, eating, drinking alcohol and smoking also affect it.

Usually, the average body temperature of kids is higher and also that of females is higher than males. Since it is sensitive to many hormones, during the menstrual cycles of women the basal body temperature rises sharply after ovulation as estrogen production decreases and progesterone increases. Taking all these factors into account the normal body temperature or normothermia has been stated as between 97.7° and 99.5° F beyond which the condition is called fever. This range is maintained by thermo-regulation, where lowering and rising of temperature is triggered by the Central Nervous System.

Called as “blood heat” in the 19th century the average normal body temperature was quoted as 98° F in most of the textbooks. But later, a large number of studies revealed it to be 98.6° F. Then in 1868, a German physician Carl Reinhold August Wunderlich set it in his book as the standard which was universally accepted for clinical use. However, since then the average human body temperature has been found to be declining steadily.

Researchers have arrived at the conclusion by studying three large databases – 23,710 readings recorded between 1862 and 1930, 15301 readings taken from 1971 to 1975 and 1,50,280 readings from 2007 to 2017. According to their observations, the body temperature of men born in the 2000s is on an average 1.06° F lower than that of the men born in 1800s. In the case of women, it is 0.58 °F.

The reason behind it has not yet been established conclusively. However, according to the scientists including Dr Julie Parsonnet, Professor of Medicine at the Stanford University and the lead author of a paper on the topic published in the January 2020 issue of the American journal *Wired*, our modern lifestyle, which has helped lower the resting metabolic rate, may be responsible for it.

Besides, today we are physiologically different from what we were in the past centuries. Our living environment, our contact with microorganisms, our food habits, etc. have greatly changed. May be these factors are somehow related to the decline of our average body temperature.

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and camera, they were able to look closely at how the inside of the material changed over time.

They found that the rate at which the material reorganised itself showed burst-like patterns persisting over thousands of seconds, resembling seismic foreshocks and aftershocks. These events usually happen over hundreds of kilometres during

earthquakes. “We were able to observe this phenomenon at about 10-micron scale length. That is a huge advantage,” says Pradip Bera, first author and a PhD student at the Department of Physics, IISc.

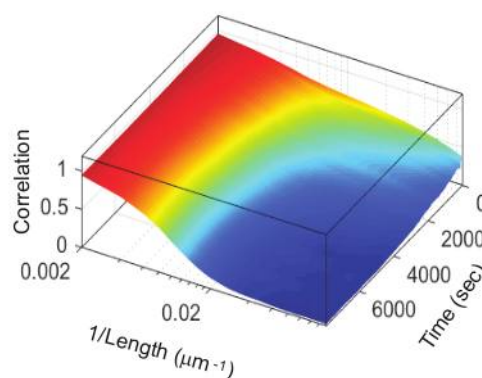
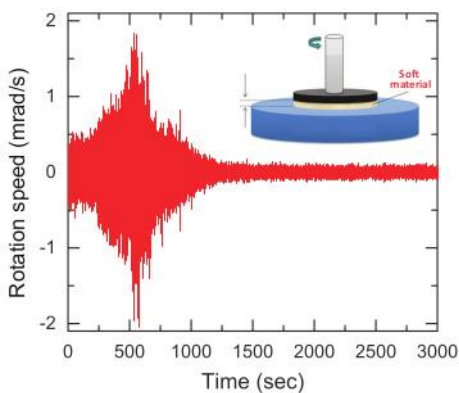
The researchers also found that these patterns obeyed laws that govern earthquake dynamics. One of these, called the Gutenberg-Richter law,

describes the strength of earthquakes. Another, called the Omori law, describes how the frequency of aftershocks reduces over time. Values for mathematical parameters defined by these laws, when calculated for the soft materials, were found to be very close to those that have been reported for real earthquakes. The time gaps between spikes were also found to closely match real-life patterns.

The researchers hope that further studies on such materials will eventually help identify microscopic precursors of earthquakes.

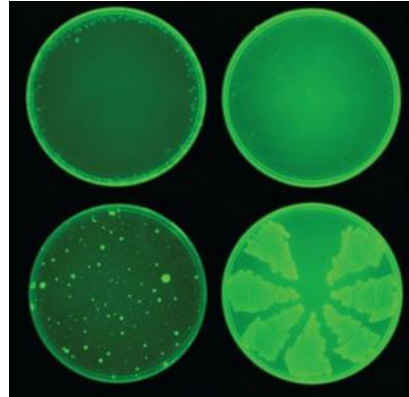
Reference

Quantitative earthquake-like statistical properties of the flow of soft materials below the yield stress, published in *Nature Communications*, January 2020. <https://www.nature.com/articles/s41467-019-13790-2>



Left: Measured angular speed of the top plate versus time. Inset shows the schematic of the experiment. Right: Time evolution of spatial correlation of domains, connecting burst-like event and internal reorganisations of the material (Credit: Pradip Bera *et al.*)

Halicin (top row) prevented the development of antibiotic-resistant bacteria *E. Coli*, while the antibiotic drug ciprofloxacin (bottom row) could not
Image Courtesy: Collins Lab, MIT (USA)



Drug Discovered by Artificial Intelligence

HALICIN, a new drug discovered using Artificial Intelligence (AI), has emerged as a promising antibiotic, effective against a broad range of resistant strains.

Antibiotic resistance among pathogens is a growing concern among scientists and laymen. Antibiotic resistance occurs when bacteria mutate and evolve to use alternative mechanisms and become resistant to antimicrobial drugs. With no new antibiotics to tackle this growing resistance, approximately 10 million lives around the world could be at risk each year from infections by 2050, according to a British study.

The new antibiotic *Halicin* was discovered by an artificial intelligence

system at Massachusetts Institute of Technology (MIT). A machine learning algorithm was used to identify molecules that are capable of killing bacteria. To achieve this, the machine was fed with atomic and molecular features of nearly 2,500 drugs and natural compounds against *E. coli*. Once this algorithm was learned by the machine, it was subjected to a working library of almost 6,000 compounds to identify the potential antibiotics.

Halicin kills some of the most dangerous strains of bacteria. Tests have proven that the drug wiped out dangerous strains including *Enterobacteriaceae* and *Acinetobacter baumannii*, which are high priority pathogens that the World Health Organization (WHO) ranks as critical for new antibiotics to target. Tests on bacteria collected from patients showed that *Halicin* killed *Mycobacterium tuberculosis*, the bug that causes TB, and strains of *Enterobacteriaceae* that

are resistant to carbapenems, a group of antibiotics that are considered the last resort for such infections. *Halicin* also cleared *C. difficile* and multidrug-resistant *Acinetobacter baumannii* infections in mice.

Jonathan Stokes, the first author of the research paper said that the process of identification by the machine took only a few hours. The scientists are now preparing for a study with a larger number of drugs.

Contributed by Jyoti & Harshada, MSc (Science Communication), CSIR-NISCAIR, New Delhi

New Mini Moon of Earth

A new mini-moon was observed by researchers Kacper Wierzchos and Teddy Pruyne at the NASA-funded Catalina Sky Survey in Arizona on the night of February 15. It is about the size of a car roughly 6-11 feet in diameter. Researchers named it “2020 CD₃” – it is likely to be a carbonaceous type asteroid.

According to the astronomers, this finding is very important because the miniature moon is only the second asteroid known to orbit Earth after the 2006 RH120 which



was also discovered by the Catalina Sky Survey. 2006 RH120 rotated the planet from September 2006 to June 2007. It was suggested that 2020 CD₃ entered the Earth’s orbit around three years ago. In support of this “The Smithsonian Astrophysical Observatory’s Minor Planet Center” announces that no link was found for the known artificial object and it is likely the captured asteroid in the Earth’s gravity.

The researchers found that it has a rambling loop around the Earth about every four months or so. But it is temporarily bound to the Earth and is not in a stable orbit. It is heading away from the Earth-moon system and will likely escape in April. It will most likely return to orbiting the sun, although there’s a chance it could some day head straight to Earth, where it would burn up in the atmosphere in a dazzling meteor display.

Contributed by Femina Anjum Abbasi who is pursuing her PhD. Address: D/o Mr Gaffar Mohammed, Near Char Perron Ki Dargha, Sadul Colony, Bikaner-334001, Rajasthan. Email: feminaanjum@gmail.com

Human Hair can Cost Pigeon their Toes

THE hazard of *manjha*, used as a string for kite flying, as a cause of threat to humans and animals

has been in the news for quite some time. Now, a new threat has come to the fore that supposedly affects only pigeons. A study by researchers in the French capital has revealed that pigeons can lose their toes due to human hair. The details of the study have been published in the journal *Biological Conservation*.

The team of scientists from the National Museum of Natural History (NMNH) and the University of Lyon conducted a study on pigeons flocking in 46 sites across Paris. The study co-author Frederic Jiguet of NMNH said he came up with the idea for the study after noticing pigeons with mutilated toes as he walked through the Jardin des Plantes, a botanical garden in Paris.

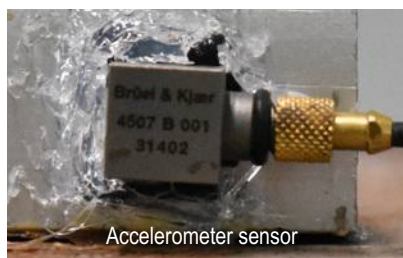
Monitoring the Health of a Structure Using Vibration-based Techniques

STRUCTURAL failures like the one in Dongri, Mumbai, 16 July 2019, and foot over bridge collapse near CST station in Mumbai 2019, can be devastating and so Structural Health Monitoring (SHM) is essential.

So far, the majority of SHM practices in India involve visual inspection and localised experimental methods that are mainly Non-destructive Testing (NDT) like ultrasonic methods, acoustic emission, etc. For large buildings like bridges and multi-storey complexes, the need for global monitoring arises that can look for the health of the structure as a single entity in its operational conditions.

Vibration-based health monitoring techniques serve this purpose. Vibration-based SHM is based on measuring the vibrational properties of a structure like frequencies and its vibrational patterns (technically speaking, mode shapes). Damage in a structure causes a change in its frequencies and vibrational pattern as compared to its undamaged case.

Vibration-based techniques try to find the location and the severity of the damage based on the measurement of the vibrations of a structure. This is done



using sensors (e.g., accelerometers), which measure the time history of vibrations.

For a building, the sensors can be installed at each floor and other critical locations to get sufficient accuracy. The data captured by all the sensors is analysed to get the vibrational frequencies and vibrational patterns of the structure. Damage in any portion of the structure causes changes in its structural properties, like stiffness, causing vibrational frequencies to drop and vibrational patterns to change. Any outlier in the vibration patterns alarms the owner for a potential damage location with corresponding damage severity.

Vibration-based monitoring is gaining huge attention worldwide. The Shanghai tower in China has 400 sensors installed along its height, continuously monitoring the structure. The Tsing Ma Bridge in Hong Kong is the longest suspension bridge and is being monitored since 1997 using sensors. In India, the Naini bridge in Prayagraj is being monitored continuously. The Signature Bridge over the Yamuna in Wazirabad, Delhi, is monitored by the Mageba ROBO® CONTROL SHM system.



However, the major hurdles in the widespread use of Vibration-based SHM are its cost, effectiveness under varying environmental conditions, and data handling capacity. Recent research works focus on achieving the same accuracy with a limited number of sensors. Developments in data management and data storing capabilities are further adding to its efficiency, opening doors for its popularity.

Contributed by Kumar Anjneya, Research Scholar, Department of Civil Engineering, IIT Kharagpur, Kharagpur, West Bengal. Email: kanjneya@gmail.com and Koushik Roy, Assistant professor, Department of Civil engineering, IIT Patna, Bihar. Email: koushik@iitp.ac.in

Jiguet said the birds are “victims of our pollution, our activities”. The team found that pollution likely played a role in nearly all cases of missing or mutilated toes in pigeons. Pigeons living in areas with higher rates of air and noise pollution tended to have fewer digits than those that lived in leafier environs.

However, this is not the first explanation for the pigeons’ missing toes. The widespread belief is that pigeons get foot infections from sitting

on their own excreta. Some believe that chemicals and metal spikes used to deter them may also cause toe injury.

A very shocking fact came to the notice of the team that found that toe mutilation in pigeons “tended to increase with the density of hair dressers”. The human hair after being cut are disposed off as waste and this is the real culprit, said the researchers. Jiguet said that the pigeons could lose digits while getting stuck in human hair, a phenomenon called “string feet”.

Can mutilation of pigeon toes be an indication of the extent or level of pollution of a particular place? Commenting on this, Jiguet said, “It will be interesting to look in all major cities in the world, to look at how many toes pigeons have to estimate the quality of the environment and the pollution.”

Contributed by Dr P.K. Mukherjee, 43, Deshbandhu Society, 15, Patparganj, Delhi-110092. Email: mukherjeepradeep21@gmail.com

COVER STORY

Chenab Bridge

An Iconic Masterpiece in the Making

Neha Tripathi

A masterpiece coming up in India is the Chenab Bridge project - an engineering milestone that will be the world's highest rail bridge connecting Kashmir to the rest of India.





BRIDGES are among the greatest inventions of mankind. They connect civilisations. They connect two pieces of land. They connect the hearts and souls of people.

Bridges have travelled a long and successful journey. From a fallen tree dragged into position to serve as a plank, to forest tendrils intertwined as an elementary suspension bridge or rafts tied together in a pontoon, to bridges that stand today as marvellous pieces of architecture. Today bridge building is like fighting a war up high near the sky or down in the valley. Bridge building has today evolved into a highly technologically intensive and scientific endeavour.

“Chenab Bridge would break the record of the Beipan river Shuibai railway bridge at 275 m height in China’s Guizhou province.”

One such masterpiece coming up in India is the Chenab Bridge project being built in Kashmir. It is going to be an engineering milestone in that it will be the world’s highest rail bridge being built by the Indian Railways. The purpose of the bridge is to connect the heaven on earth, Kashmir, to the rest of India. Work is in progress and is expected to be completed by 2021. The Kashmir Valley has also got a gift of 200 kilometres of roads under the Chenab Bridge project connecting various interior villages to National Highways and main roads.

The workers are on a humungous mission at a place where geography is not very kind to them. They are busy building the next wonder of the world. This is like a war for them, where they are fighting with weather conditions, chilly and snowy winters, the mountainous terrain, the height and the slope, and several other technicalities.

The Chenab Bridge will be a part of the 272 km railway route from Udhampur to Baramulla in Kashmir. It is also

“The purpose of the bridge is to connect the heaven on earth, Kashmir, to the rest of India. Work is in progress and is expected to be completed by 2021. The Kashmir Valley has also got a gift of 200 Km of road under the Chenab Bridge project connecting various interior villages to the National Highways and main roads.”

known as the Udhampur-Srinagar-Baramulla Rail Link project (USBRL), constructing which comes with a package of significant engineering challenges. The project involves 200 km of access roads, 27 tunnels and 37 bridges.

Out of this 272 km railway route, 161 km length is divided into two stretches. One stretch is of 136 km from Banihal to Baramulla and the second stretch is of 25 km from Katra to Udhampur. This segment of the stretch has already been constructed and commissioned in different phases from year 2009 to 2014. The intervening portion of 111 km long from Katra to Banihal is more challenging being treacherous and rugged. The alignment crosses a deep gorge of the Chenab valley necessitating the construction of a high bridge on the steep slope.

The bridge is a steel and concrete arch which consists of two parts. The first part is the arch that helps in bridging the river. The second part of the bridge is a Viaduct, an approach span having piers of Reinforced Cement Concrete (RCC). Here, to increase the tensile strength, mild steel bars are used in cement concrete thereby reinforcing it.

The arch is a large steel framework made of 24,370 tonnes of steel. The chords are sealed steel boxes which are internally stiffened and filled with concrete to assist in controlling wind-induced forces on the bridge. Another advantage of concrete filling is that internal painting will not be required.

The number of bearings has been minimised, as it reduces the maintenance and inspection efforts, and improves the riding quality. Chief Engineer of the Chenab Bridge Project Mr B.S. Tomar informs that in one of the foundations of the main arch, approximately 3.5 lakh cement bags have been consumed!

The design of major arch rail bridges requires considerations of a number of additional parameters such as fatigue, global stability, second order effects, composite action, etc. The bridge has anti-terror features. The bridge is designed in such a way that even if one of the 17 piers is blown up, it would not lead to collapsing of the bridge.

The most stunning part of the entire structure is the level difference between Katra & Banihal. This difference is approximately 890 meters. One side of the bridge is higher than the other side, thus making a bridge parallel to the

The bridge has anti-terror features – even if one of the 17 piers is blown up, it would not lead to collapsing of the bridge



A challenging aspect of the project was that the height of the bridge was supposed to be increased above all expected levels

ground was next to impossible. So, the height of the bridge was supposed to be increased above all expected levels.

Principal Executive Director (Bridge), Railway Board, Mr A.K. Singhal explains, “Of course, engineers had the option to construct a bridge across the river Chenab at a lower elevation. But in that case for meeting the level difference, the gradient between Chenab Bridge and Banihal station would have been much steeper than what was planned. This would have restricted the haulage capacity of moving trains. Also, due to steeper gradient, a number of slip and catch sidings would necessarily be constructed making the operation

of trains quite tedious, risky and also at a higher cost as compared. So, there was no option but to have a high bridge across the Chenab River.”

Building such a masterpiece required a high level of upgradation in the technology used. However, when the project was initiated, there were no facilities, no roads to travel, no place to relax. But, today approximately 200 km of road has been developed around the area, joining Jammu and Kashmir.

Constructing such special bridges is always technology intensive. For instance, to erect such a massive structure at such a height, using a cable crane was a project in itself.

“In British era, India witnessed construction of two major hill rail lines – one in Shimla and the other in Darjeeling. Both of them are narrow gauge lines used for toy trains with speeds of 10-15 kmph.”



Chenab Bridge – The Highest Bridge

- Bridge length: 1,315 m or 4,314 ft
- Bridge length includes 650 m or 2,130 ft long viaduct on the northern side
- Arch length: 480 m or 1575 ft
- Arch span: 467 m or 1,532 ft
- Height above river bed: 359 m or 1,178 ft
- Height above river surface: 322 m or 1,056 ft
- 14 m-wide dual carriageway
- 1.2 m-wide central verge



Extraordinary Features

- It is 35 metres taller than the Eiffel Tower in Paris, France
- It is the seventh-largest arch-shaped bridge in the world
- It is partly in straight horizon and partly in curves
- It can withstand winds up to 260 kmph
- Lifespan will be 120 years
- It can handle speeds up to 100 kmph
- Challenging, fragile and daunting geology, treacherous terrains, rugged Himalayan Mountains

This type of Arch Bridge is being constructed for the first time in the Indian Railways



Unique Design

The design of the bridge is unique as it would be arch shaped, standing tall on two legs far apart. These legs are actually the steel pillars on both sides of the river bank. The pylons on either side of the river are about 130 m and 100 m high and two auxiliary self-propelled cable cranes were used to tow temporary auxiliary ropes across these pylons. The ropes support the partly finished arch parts. After arch completion, the trusses will be added; finally the girder will be constructed as a horizontal sliding type platform. The arch is being supported by piers and trusses. This type of Arch Bridge is being constructed for the first time in the Indian Railways.

Bridges are designed considering the topography, environmental and geotechnical aspects apart from various loads acting on the bridge components. Mountainous terrains, deep gorges, tall piers, unequal height of piers, poor soil conditions, floods in rivers, snowfalls, heavy rainfall, seasonal and diurnal temperature changes, high wind and seismicity are some of the challenges with respect to design of bridges. Depending upon the purpose of use – Pedestrian, Road vehicular traffic or Railway Movement – the loading characteristics are assumed and the design is finalized.

Similar Examples of Engineering Milestones for Railways

Bogibeel Bridge on river Brahmaputra in Assam

- It is the longest rail-cum-road bridge in India
- It measures 4.94 km over the Brahmaputra river
- It is India's first bridge to have fully welded steel-concrete support beams
- It is situated in an earthquake-prone area
- It can withstand earthquakes of magnitudes up to 7 on the Richter Scale
- It has a serviceable period of around 120 years
- It is the fifth longest bridge in India after Bhupen Hazarika Setu, Dibang river bridge, Mahatma Gandhi Setu and Bandra Worli Sea Link
- It is Asia's second longest rail-cum-road bridge

Pamban bridge at Rameshwaram

- It is India's first railway sea bridge
- It is situated in a marine environment
- Designed for wave action and cyclonic storm
- It has a span which could be opened for ship traffic

Again, based on life span of the bridge, selection of the material is decided i.e. Steel Bridge/PSC Bridge/Composite, etc. which in turn again depends on local availability of material and cost factor. Geotechnical and environmental conditions also play an important role in bridge design as it may be affected by weak soil, winds, earthquake, corrosive environment, etc. Further, availability of machinery and experienced manpower together with funding, and life cycle analysis may lead to varying designs.

Mr Parag Verma, Chief General Manager of Business Development at IRCON International Limited, a specialised construction organisation providing services in the infrastructure sector with core competence areas of Railways and highways construction highlighted the above aspects of designing such bridges.

Materials Used

A unique structure like the Chenab Bridge is built with the help of some unique materials, which include:

- High quality steel of Grade E250C being used for fabrication of deck superstructure. The C grade steel has special toughness properties at subzero temperature making the steel enough ductile in chilly cold weather conditions. Z grade steel used in fabrication of Arch has special thickness properties preventing lamellar failure of steel plates.



The major challenge was the jointed, weathered and weak Himalayan rocks in the area

- Double corrosion protected Dywidag bars, pre-stressed high tensile steel threaded bar used for slope stabilization with the requisite tensile strength.
- Cable anchors are used for stabilization of more critical slopes such as below the main Arch foundations.
- For steel to steel interfaces, multi-metal grout with pressure has been used for ensuring 100% contact in between, so as to prevent any point loading causing rupture.
- For maintenance, regular painting of large bridges is an intimidating task. Hence, a painting scheme was developed, having renewal of over 15 years, compared to approximately 5 to 7 years in most other Indian railway bridges.

Construction Methodology

By virtue of the Chenab Bridge’s location, terrain and uniqueness of structure, the desired shape, design and layout are on the verge of completion with application of specialised methodology for construction of Chenab Bridge.

Chief Engineer of the Chenab Bridge Project Mr B.S. Tomar explained in detail the difference in construction methodology of this bridge from other bridges. “To start with, the major challenge was the jointed, weathered and weak Himalayan rocks in the area. So, to fill up the fissures between rock joints, consolidation grouting or hardening of the founding areas have been done for their strengthening before casting of foundations.”

Tomar added that two of the world’s longest cable cranes of 915 m span were used for erection of components and segments of arch, piers & trestles. Two cable cranes of

Maintaining Bridges

The challenges do not stop with design and construction but maintaining the bridges for a design life of more than 100 years is another major challenge.

The CSIR-Central Road Research Institute popularly known as CRRRI, a constituent laboratory under the Council of Scientific and Industrial Research (CSIR) has contributed to the design and proof checking of many bridges. When asked about the latest technology used by CRRRI in building bridges, CSIR-CRRRI Director Mr Satish Chandra mentioned that in railway yards, a number of cable stayed bridges have been built, for example Krishnarajapuram bridges, Burdwan bridge and so on. Therefore, construction of cable-stayed bridges is gaining momentum in both road and railway sector although erection of bridges over railway yards without stopping train traffic is a major challenge.

Apart from technology, skilled manpower is another constraint. CRRRI Director Mr Satish Chandra emphasised on periodical refresher courses and customised training programs under CSIR-integrated skill initiative to upgrade the skill of practicing engineers with latest advancements in bridge design and construction.

This skilled manpower is the need of the hour. For any structure as unique and as wide as the Chenab Bridge, only machines can’t work, machines and skilled labour complement each other. Chenab Bridge will surely get space in historical documentation and would be remembered over centuries.

Two of the world's longest cable cranes of 915 m span were used for erection of components and segments of arch, piers & trestles



individual load carrying capacity of 20 MT & in combined capacity of 37 MT are being used. They are using self compacting concrete for filling in hollow steel ribs of main arch to increase weight and enhance lateral stability of structure against high wind speed loading.

More than 85% of steel fabrication is carried out at site workshops with world class latest welding machines and methods such as customised automatic twin arm SAW machine, Flux Core Arc Welding (FCAW) and NDT by Phased Array Ultrasonic Testing (PAUT) instead of conventional Radiography Testing (RT). The steel used in the bridge is blast proof and the Railways is also installing an online monitoring and warning system to ensure swift response if the need arises.

The Chenab site lab has been accredited with National Accreditation Board for Laboratories (NABL) certification for testing of welded elements for the first time on

Indian Railways. And for the first time continuous welded plate girder has been used on any Railway Bridge. The bridge has been designed to bear earthquake forces of zone V, which is the highest intensity seismic zone in country.

The height of the steel pier at one of the main arch foundation is 130.855 M, which is quite higher than the Qutub Minar (73 m) indicating the mammoth nature of the structure.



The steel used in the bridge is blast proof

Challenges

The most difficult part of this railway project is crossing the deep gorge of the Chenab River located at the Salal Hydro Power Dam. Another challenge is the large number of tunnels with total length of 63 km, as well as bridges of 7.5 km. These have to be constructed on the highly rugged and mountain terrain of the Himalayas.

Secondly, stabilisation of the foundation and erection of the bridge were other major challenges in hand. For stabilising the arch, it is needed to control the deflection by anchoring the arch by numbers of forestay and backstay cables at nodal points. When wind speed exceeds 50 kmph, the erection work has to be stopped. Every work at such a great height – whether it is a permanent or temporary one – is quite risky and needs to be done with utmost care and skill. The work at this height is carried out after fixing wire net underside so as to arrest fall of any object or material.



Stabilisation of the foundation and erection of the bridge were major challenges

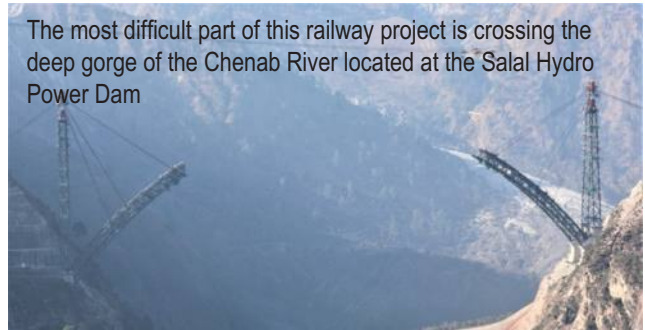
A major challenge is the large number of tunnels with total length of 63 km, as well as bridges of 7.5 km. These have to be constructed on the highly rugged and mountain terrain of the Himalayas.



Historical Masterpieces

- The railway bridge across the Mahi river at Bhairongarh, Madhya Pradesh, near Ratlam, was built in 1890.
- Nethravati Bridge goes across the Ullal River, near Mangalore, Karnataka, was built in 1907.
- Havelock Bridge, also called the Old Godavari Bridge, at Rajahmundry, Andhra Pradesh, was decommissioned in 1997 and is now a national monument.
- Koilwar railway bridge, now called Abdul Bari Bridge, over the upper Sone river, Bihar, began in 1856. It was completed in 1862, after the First War of Indian Independence of 1857 halted its construction.
- Aryankavu bridge at Kazhathuruthi, near Punalur, Kerala, on the Kollam–Sengottai branch line is nearly 110 years old.
- At Allahabad, Uttar Pradesh, both trains and motor vehicles cross the Yamuna, near its confluence with the Ganga, on the double-deck, steel-truss, 1,006-metre Old Naini bridge built in 1865.
- The 1854-built Dapoori viaduct, on the Great Indian Peninsula Railway, crossed the Mula river.
- The Nanjangud railway bridge, connecting Tandavapura and Nanjangud stations, over the Kabini river in Mysore district was built in 1735 and is a heritage site. Built first as a passenger bridge, for horse, camel and bullock carriages, in brick sand and stone, by Dalvoy Devraj, in 1902 it was converted into a railway bridge.

The most difficult part of this railway project is crossing the deep gorge of the Chenab River located at the Salal Hydro Power Dam



Special workers used to working at great heights such as thermal power plants, refineries & oil industry, ship building, etc. have been hired for the tedious & cumbersome erection work. These workers are tested daily for their critical medical parameters and only healthy workers are then allowed to work. While working with cable cranes, tightening of HSFG bolts, installing temporary platforms, etc. these workers have necessarily to wear safety jackets for their safety.

Some other challenges include availability of high strength materials like stay cables, equipments required for bridge erection, trained manpower for precision welding and painting, etc.

While the Chenab Railway bridge project is indeed a challenging prospect and an object of pride for Indian workmanship, let's also give tribute to the hundreds of bridges being built by local people in remote areas without any steel or crane. These people are not skilled but the challenges they face have motivated them to innovate and build bridges with a difference.

Most images have been provided by the Chief Engineer working on the Chenab Bridge project.

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OBITUARY

Prof. V.L. Chopra

Eminent Geneticist and Great Institution Builder

PROF. M.S. SWAMINATHAN

Padma Shri, Padma Bhushan, Padma Vibhushan
Father of Green Revolution in India

I joined the Genetics Department of the Indian Agricultural Research Institute (IARI), New Delhi, in 1954. One of my duties was guiding students for their PhD degree. The two earliest students were A.T. Natarajan and V.L. Chopra. Both of them were brilliant and Natarajan was the first PhD scholar of Delhi University from IARI. Chopra was engaged in research on the chromosomes of wheat. He prepared a chromosome map and this was highly appreciated by wheat research workers worldwide.

During the time Chopra was working with me, Prof. Auerbach from the University of Edinburgh expressed a desire to provide facilities to Chopra in her department. Chopra finished his PhD work at Edinburgh and Dr Auerbach was full of praise for his thoroughness and sense of originality. Dr Auerbach herself received the Nobel Prize for her work on chemical mutagenesis. Chopra also continued his work along with Dr Natarajan in the Netherlands. He had also earlier worked in Sweden. On return to India, he became Professor of Genetics at IARI.

In 1983, India hosted for the first time the International Congress of Genetics. I requested Chopra to be the Secretary-General of the Congress. He did a superb job and the then Prime Minister, Smt Indira Gandhi, was very impressed with his work. Next year he was awarded the Padma Bhushan by the President of India.

Prof. Chopra was not only an eminent geneticist and teacher but also a great institution-builder. Among the institutions he helped to build and which are even today very active are the National Academy of Agricultural Sciences and the Genetics Congress Trust. In both these cases, Chopra gave a lot of his time to ensure that their work was meaningful.

Prof. Chopra was admired by all fellow scientists who sought his advice while working on complex genetic problems. He guided a large number of students in their PhD work. He was a favourite teacher. Apart from that, he was a wonderful human being. He looked after his adopted daughters with great love and care. Till the last day of his life, he attended important scientific meetings and helped to shape their recommendations in a meaningful manner. Chopra's career, therefore, became one of self-sacrifice doing good work and stimulating young scholars through personal example. He was a scientists' scientist.

And to me, it was good fortune that I could work with him in conceiving and building the National Academy of Agricultural Sciences and several others. We all pray for

Prof. V.L. Chopra

Visionary Scientist, Outstanding Administrator, Exceptional Teacher



Prof. V.L. Chopra being felicitated by Dr Sanjay Kumar, Director, CSIR-IHBT

DR SANJAY KUMAR
 Director, CSIR-Institute of Himalayan
 Bioresource Technology
 (CSIR-IHBT), Palampur

SERVING the Nation till the last day, Prof. Virender Lal Chopra left for heavenly abode on 18 April 2020 leaving behind a shocked and grieved scientific community.

Bestowed with innumerable prestigious awards including Padma Bhushan, Borlaug Award, Dr BP Pal Award of NAAS, Aryabhata Medal of INSA, INSA Silver Jubilee commemoration medal, O.P. Bhasin Award, FAO/IAAS World Food Day Award, Honour Summus Medal USA, Federation of Indian Chambers of Commerce and Industries Award, Prof. Chopra remained humble to the core and will serve as a role model for youngsters.

Prof. V.L. Chopra was born in Adhwal (now in Pakistan) to Shri Harbans Lal and Smt. Sukhwanti. Growing in an academic environment, his father being a School Principal, Prof. Chopra had an inherent liking for academics since childhood and pursued the subject of his choice as profession.

The family moved to Delhi and Prof. Chopra completed his schooling from Ramjas School Delhi, graduation in Agricultural Science from Central College of Agriculture, New Delhi, followed by Associateship at the Indian Agricultural Research Institute (IARI) and PhD in Genetics from the University of Edinburgh. An intense urge to serve the motherland brought Prof. Chopra back to the country and he joined the Department of Genetics at IARI, New Delhi.

His scientific intellect was unparalleled and he made an unprecedented contribution in biotechnology as Professor of Eminence & Founder Director of National Research Centre on Plant Biotechnology. During this time, he was also a member of the scientific advisory committee to the

Prime Minister of India. Thereafter, he took up an overseas assignment to Vietnam and played a pivotal role in the establishment of the Agriculture Genetics Institute (AGI) in Hanoi.

In 1992, he was appointed Secretary to the Govt of India, Department of Agricultural Research & Education (DARE) and Director General, Indian Council of Agriculture Research (ICAR). He was also a Member of the Planning Commission of India. Further, he served as Chancellor, Central Agricultural University of Imphal and Central University of Kerala.

Prof. Chopra worked with Prof. M.S. Swaminathan's group and chose to work on mutagenesis of wheat using radiation biology. He made commendable contribution in building the food security of our country by developing new varieties of wheat to cater to the specific needs of farmers in different agroclimatic regions of India. He published over 150 research papers in refereed research Journals of repute. He had wide experience of working with leading international organisations like FAO, IFAD and CGIAR. He also served as President, International Genetics Federation.

Owing to his immense scientific contributions, he was elected fellow of several International and National Academies including Third World Academy of Science, Trieste, Italy; European Academy of Science, Arts & Humanities, Paris; Indian National Science Academy, New Delhi; Indian Academy of Sciences, Bangalore; National Academy of Sciences, India, Allahabad; National Academy of Agricultural Sciences, New Delhi. Banaras Hindu University, Varanasi and CS Azad University, Kanpur, conferred him the DSc degree.

His urge to serve the society brought him close to NGOs where he rendered service as Member Board of Trustees in M.S. Swaminathan Research Foundation, Chennai; Gujarat State Fertilizers and Chemicals Research Foundation; Tea Research Association and Centre for Advancement of Sustainable Agriculture.

Love for the Mountains

With an endearing love for the mountains, Prof. Chopra's association with Himachal Pradesh goes back to his early career days when he trekked to remote high altitude locations whenever opportunity permitted, the thrill of which he shared in discussions during later years.

One such incident he shared was a bold uphill trek to Rohtang pass from Katrain (ICAR-IARI, Regional Station) in Kullu district of Himachal Pradesh (HP), somewhere in the 1960s. This perhaps laid the basis of his decision to have a second home in HP at Palampur.

Over a period of time, he travelled and trekked extensively in the mid-high mountains to trans-Himalayas (Lahaul & Spiti valleys) for having a first-hand account of mountain life and its resources, the benefit of which can be seen in his sound advice in policy documents, books, and formal/informal interactions with policy planners, academicians, researchers, foresters, NGOs, farmers and students.

Palampur Sojourn

In the year 1998, he purchased a house in the Housing Board Colony at Bindraban, Palampur, located on the fringe of the landmass that overlooks a ravine, and the beautiful Dhauladhar mountain range. During his stay in this house, often he would sit for hours in the veranda or lawn of this house and seemed always to be enjoying the solitude. He spent considerable time maintaining an excellent lawn and a refreshing collection of flowers.

Given to rising early in the morning, he was most regular in walks and often ventured out to explore new nearby slip roads leading to small gorges, rivulets or less frequented areas in the wild. He managed his household affairs all by himself when alone at Palampur, and except for trivial domestic help for cleaning the floor, he never allowed anyone to wash cookware/dishes or clothes. He meticulously cooked a variety of dishes and experimented with a few ones.

Prof. Chopra had an amazing ability to be contented all by himself; in discussions, it was a treat to hear him for his crisp comments and critical insights. A compassionate heart and a great sense of humour poured out in hilarious anecdotes from his fond memories of childhood and later days. His recollections also carried accounts of bitter memories of pre- and post-Indo-Pak partition shift in 1947, settlement of the family in Delhi, his father as headmaster, and his getting tutored at home during the initial years of primary education. His frequent recounts reflected him to be deeply attached to his mother whom he often and very fondly remembered for her strong influence of merit. "She was self-reliant all through," he recalled once with moist eyes and stated that even on the last day of her life, she had washed her clothes in the morning and put them to dry.

Association with CSIR-IHBT

I was fortunate to have known Prof. V.L. Chopra for over three decades since my student days at IARI (1986-1990) when he exposed us to the world of "Restriction Fragment Length Polymorphism (RFLP)" by none other than N-H Chua, at a time when this technique was just evolving. He was a teacher *par excellence*.

Later, I joined the CSIR-Institute of Himalayan Bioresource Technology (then CSIR Complex Palampur) in the year 1990 and it was a blessing for all of us to have his mentorship for a very long time, by way of his regular visits to the institute, starting in the mid-1990s to recent times, and more specifically during his Chairmanship of the Research Council of the Institute for two consecutive terms (from 1998 to 2002).

In fact, he had been a guide and mentor to the entire CSIR family through his long association with different CSIR Labs (Member of CSIR Society 2006-2009, Chairman RC CSIR-NBRI, Chairman Biodiversity and Biotechnology Policy for Jammu & Kashmir State 2010 drafted by CSIR-IIIM, Jammu, to quote some).



A great visionary in science, Prof. Chopra played a key role in shaping the research landscape of CSIR-IHBT and was kind enough to mentor the institute almost till the final stage of his life (chaired the monitoring committees of Aroma Mission, Niche Creating Projects and Frontier in Basic Research projects under Agri-Nutri Biotech theme).

He emphasised on bioprospecting the resources of the Himalayas so that the institute could carve a niche for itself and cater to the needs of the country. He encouraged researchers towards documenting and mapping the rich biodiversity of Himalaya and motivated them to spend more time in the field with the local communities so as to learn from their wisdom. He also exhorted researchers to actively participate and contribute to climate change research.

While he believed that fundamental science is the strength of an R&D institute, he also made sure that the benefit of science reached the society, industry and academia. He contributed significantly in framing of several socially relevant key projects that helped in catalyzing rural economy and suggested getting these evaluated through third-party analysis. He also focused on developing a business plan of the Institute and emphasised on Return on Investment (ROI) evaluation on the business module. Complying on his suggestions greatly benefited the Institute during the commercialisation of technologies at a later stage.

His art of spontaneous oration on matters of science and its relevance to society won hearts of many who fondly recollect his enlightening talks delivered during National Science Day, National Technology Day, and Foundation days of CSIR and IHBT. These were enthused with great power to ignite and motivate students, academicians and the general public of Palampur town.

Being a prolific thinker, Prof. Chopra authored many books, some with the scientists of the CSIR-IHBT viz., *Technologies for Livelihood Enhancement, Climate Change and its Ecological Implications for the Western Himalaya, Ornamental Plants for Gardening* and *Medicinal & Nutraceutical Plants from The Himalayas*.

Other than CSIR-IHBT, the diverse scientific fraternity in the town of Palampur, ranging from Palampur Centers of Indian Veterinary Research Institute and Indian Grassland and Fodder Research Institute, as well as other scientific institutions within the state, including foresters held him in high esteem for his guidance, valuable advice and direction, in official capacity or otherwise.

We all join to pay our homage to late Prof. Chopra, who was a visionary scientist, an outstanding administrator, an exceptional teacher and a compassionate person who loved and lived only science and his profession.

PROF. ARUN TIWARI

Missile Scientist & Former member of advisory team to President of India

My association with Prof. V.L. Chopra was for a day. We met at CSIR-IHBT as guests for the Foundation Day on 1 October 2018. Prof. Chopra sat with me in the lawns of the guesthouse for over two hours in the pleasant evening marked by well-organised lights falling on the immaculate landscape.

That evening was like the proverbial meeting of Tulsidas with Shri Rama in disguise on the Ganga-ghat in Varanasi. I first felt that I was talking to Dr APJ Abdul Kalam back in the mortal form, but soon realised that I was talking to the immortal human spirit of science that had once manifested through Dr Kalam and that was talking to me through Prof. Chopra.

Prof. Chopra would speak in a tone that was so soft, bordering on being musical, choosing his words so precisely that they were almost lyrical. He told me that like Mahatma Gandhi's seven social sins, there are seven scientific sins and that we must not only refrain from falling into them, but we are also duty-bound to save others, especially the youngsters. He first enumerated the seven social sins by raising his fingers one by one – “wealth without work”, “pleasure without

conscience”, “knowledge without character”, “commerce without morality”, “science without humanity”, “worship without sacrifice”, and “politics without principle”.

Then, he told me the seven scientific sins, folding back one by one, his seven raised fingers – “hypothesis without conviction”, “observation with bias”, “cowardice in accepting error”, “defence when proved wrong”, “asserting without evidence”, “persisting in delusion”, and a “career without curiosity”.

I asked him how he felt heading a giant organisation like ICAR. He replied that it was a humbling experience. Although our farmers need real science, we are lost in semantics. Farmers are the only reality of India; the rest is show. Science is not about fighting the existing reality. It is about building a new model, a new method to deal with the reality that makes the existing model obsolete.

Prof. Chopra has left the mortal world that all of us will leave someday or the other. What is important is what we leave behind. I believe in reincarnation and liberation; one of the two is waiting for us. Prof. Chopra has been liberated of the physicality and has merged with the Immortal Absolute. I wish that his teachings live on through his blessed students and that his example of what it means to be a nobleman is emulated.

PROF. SUDHIR KUMAR SOPORY

Padma Shri, SERB Distinguished Scientist

Former Vice-Chancellor, Jawaharlal Nehru University, New Delhi

It has been my privilege to have known Prof. V.L. Chopra, an outstanding geneticist and agricultural scientist and an educationist for over three decades. In fact, he had vast knowledge, much beyond his area of research and specific domain that it was always a learning experience to talk and discuss with him.

On one occasion we were together in Beijing for a meeting and went together to see the Great Wall of China. A memorable time I spent in his warm company.

I had also many opportunities to be with him in several meetings of ICAR, CSIR, DBT. A very polite person, yet

very forthright in his comments and criticism, he would always speak his mind. His views and suggestions were always helpful.

Dr Chopra was a passionate and principled researcher. It was his vision that brought in new breeding tools and techniques, based on new concepts and knowledge in the area of genetics, cell biology and genomics, at the doorstep of agricultural institutions. He laid the foundation for the National Research Centre in Plant Biotechnology at IARI. He believed that there are no boundaries between fundamental and applied agricultural research.

The fraternity of agriculturists, biotechnologists and plant scientists will miss Dr Chopra forever. Besides his achievements and attainments, he was a very down-to-earth person, a pleasant personality and always very well dressed. One aspired to meet and talk to him.

PROF. BALDEV SINGH DHILLON

Padma Shri, Vice-Chancellor, Punjab Agricultural University, Ludhiana

Prof. V.L. Chopra was a great educationist, outstanding scientist and able administrator. Above all, he was a great mentor and human being, whose self-effacing & affectionate way of interaction and magnanimity led to wholehearted engagement with colleagues and students leaving an indelible

and life-transforming impact. He did commendable research in Brassica improvement and the germplasm developed by him contributed a lot to the welfare of Indian farmers.

He devoted his life to the development and application of biotechnology in crop science and deserves to be recognised as the “Father of Agricultural Biotechnology” in India. In recognition of Dr Chopra's outstanding services to science at national and international levels, Punjab Agricultural University felt honoured by awarding him DSc (*h.c.*) in 2018.

DR OM P. SHARMA
Former Emeritus Scientist, CSIR-IHBT
Head, ICAR-Indian Veterinary Research
Institute, Regional Station, Palampur

I have had the privilege of association with Prof. V.L. Chopra over more than two and a half decades. My first audience with Prof. Chopra was on 2 June 1993, when he was on a visit to the CSIR-IHBT (the then CSIR-Complex). He was holding the august position of Director General of ICAR and I was working as a scientist in ICAR-IVRI, Palampur campus. I along with my colleague Dr T.K. Bhat (Prof. Chopra's student at IARI) visited IHBT and requested Prof. Chopra to spare time for a visit to IVRI. His response was: "Sure, science is my first love."

After extending the invitation we came back to our labs to make quick preparations for him. Lo and behold, he walked into my lab when I was busy collecting complimentary publications. I was somewhat uncomfortable to find that we could not receive him formally befitting his administrative position. However, he made me absolutely comfortable. Such was the humility of Prof. Chopra. He touched the heart of each one around him.

PROF. S.K. SHARMA
Former Director, National Bureau of
Plant Genetic Resources and former
Vice-Chancellor, CSK Himachal
Pradesh Agriculture University,
Palampur

The scientific community was bereaved to know about the sad demise of Prof. V.L. Chopra. In his death, the country has lost an eminent scientist, the void difficult to fill.

My first interaction with Prof. Chopra was in October 1971 when I joined as a PG Student in the Division of Genetics, IARI, New Delhi. The office told me to get some admission papers signed from Professor of Genetics. I located a room with this nameplate and found a young and smart person sitting on the chair. I gave him the papers and he told me that he is on sabbatical leave to avail the Humboldt Research Fellowship in Germany and is briefly in the country for a few days. He took me to Prof. S. Ramanujam who was looking after the work of Professor of Genetics in his absence. His kind gesture impressed me. During my stay of about five years or so in IARI, I met him on several occasions mainly related to academics.

During my service of 25 years in the ICAR and CSK HP Agricultural University, Palampur, I had the chance to meet and interact with him a number of times. I had the opportunity to steer the HP Agricultural University, Palampur for three years. During this period I had frequent interactions with him both as courtesy calls and also for mentorship.

I would often meet him in the evening and the discussions would continue for a long time and would be academic centric. He would invariably talk on issues of interest to the scientific community. I always found him reading, writing

We took him around the labs and had elaborate discussions for more than two hours. He was appreciative of the work and work culture in ICAR labs located in the serene foothills of the Dhauladhars. The visit was a lot inspiring and gave a great fillip to our confidence for seeking a much higher quality bar in our research programmes and publications.

I had the privilege to have long discussions with him at his Palampur residence. The topics covered were science, society and humanism. Every word he uttered was hard science and a pearl of wisdom. He often opined in his addresses to researchers that the science we do should have a seamless conduit from basic to application for eventual societal benefits. He was one of the strongest votaries of basic science.

He was a true doyen, not only a great scientist, educationist and administrator, but down-to-earth and humble, a rare combination. He had a special aura of brilliance and sagacity around him. In any professional gathering, he was the tallest, literally and intellectually.

Prof. Chopra's passing away has left a distinct vacuum in a generation of Indian science. A sure tribute to Prof. Chopra would be to follow his ideals of excellence in science and education for being competitive with the best in the world.

and working on the computer. He was a prolific writer. He was a frequent visitor to the University on several occasions and it was a great pleasure to listen to his views every time.

He donated a large number of rare and useful personal books to the University, which are being kept in the Library as 'Prof. VL Chopra Section', inaugurated by himself.

I had the pleasure of travelling with him to the remotest parts of Himachal Pradesh mainly to oversee the outreach research programmes of the University and his valuable insight was very rewarding. During these trips, he made a point to meet the farmers particularly women folk to listen to their problems and their views. He was more than comfortable with the logistics available in such remote places. The time spent with him on every such occasion was an educating experience. He was very down-to-earth and believed in simplicity.

After completing my assignment at the University, I had the privilege to work with CSIR-IHBT as CSIR-Emeritus Scientist and thus the old link of intimacy and interactions continued. He would quietly go to his office room in the Institute and after completing the work return to his residence. I would make it a point to meet him in his chamber at least once during his stay at Palampur.

In case, I was not in town, he would enquire about my well-being from others in the Institute or send a mail to enquire about my well being. His last visit to the University was during February 2019 to inaugurate the International Wheat Symposium. My last meeting with him was on 23 May 2019 at the Dharamsala Airport on our way to Delhi.

Though Prof Chopra is not with the scientific community and it is difficult to fill the void created by his death, his contributions will continue to inspire the scientific community for many generations to come.

My Reminiscence and Tribute to Prof. V.L. Chopra

DR RAM VISHWAKARMA

Director, CSIR-Indian Institute of Integrative Medicine,
Jammu



Prof. V.L. Chopra being welcomed by Dr Ram Vishwakarma at CSIR-IIIM

I am deeply saddened by the sudden passing away of Prof. V.L. Chopra, a leading scientist, teacher and policymaker of independent India. Prof. V.L. Chopra had deep imprints on the post-independent scientific research in the field of genetics, agriculture and policy. I had heard about his contributions in science since my student days but came to know him personally only in 2009.

Immediately after joining CSIR-IIIM Jammu as Director, I realised the richness of the resources of the State of Jammu & Kashmir with numerous untapped potential to create wealth and jobs. To realise this goal, I desperately needed a “Friend, Philosopher and Guide” to help me to create a practical roadmap for translating research of CSIR-IIIM into the fields of J&K and other states of India. That is when I approached him and requested his support, which he gladly reciprocated.

I must say that this fortuitous and long (11 years) association with Prof. V.L. Chopra turned out to be a game-changer and it laid down the scientific agenda of the Institute in a substantial manner. Prof. Chopra became a frequent visitor to the Institute in various capacities

including a special and permanent invitee to our Research Council chaired by another great guardian of CSIR-IIIM, Prof. Goverdhan Mehta.

Later on, Prof. Chopra accepted the invitation from the then Chief Minister of J&K to head his Scientific Advisory Committee (SAC-CM), which led to the creation of a biotechnology policy for J&K and subsequently the setting up of two Industrial Biotechnology Parks (one in Jammu and the other in the Kashmir Valley) with financial support from the Department of Biotechnology (Govt of India). This was one of the major policy and infrastructure interventions in J&K to harness sustainable natural resources and creating enterprise.

I have always been amazed by his personal grace, scholarship and desire to nurture scientific excellence among colleagues. I have not met many people in the Indian scientific community with his level of objectivity, integrity, large-heartedness and vision for Science in its multiple colours. I feel fortunate to have had the opportunity and time to learn from him. Other than science.

I will forever feel his presence in my thoughts and actions.

“If you want to avoid contracting the disease, imagine that you are infected and that you will do everything in your power to avoid transmitting it to others.”

Nobel Laureate Prof. Peter Doherty



Prof. Peter Charles Doherty is a Nobel Prize winning immunologist. He was jointly awarded the 1996 Nobel Prize for Physiology or Medicine for his pioneering work on how the immune system recognizes virus-infected cells. Their discovery laid the foundation for an understanding of the general mechanisms used by the cellular immune system to recognize both foreign microorganisms and self molecules. In an e-mail interview to **Science Reporter**, Prof. Doherty talks about the immune system and SARS-CoV-2 virus pandemic.

Meher Wan: *Prof. Doherty, thank you very much for talking to Science Reporter. It is indeed a privilege. Let me begin with asking you a question in the context of the current coronavirus pandemic. How do we keep our immune system healthy during a pandemic of this kind?*

Prof. Peter Doherty: Eat a healthy and balanced diet. There are some suggestions that taking extra vitamin D3 may be helpful, but I know of no scientific evidence specific to COVID-19. Social groups that are known to be Vitamin D deficient do seem to be particularly vulnerable, but there may be other reasons for that, or “confounding variables” as science would have it.

MW: *Different strains of SARS-COV-2 are being detected at different places among different races. Will vaccines developed for one strain be effective in the case of other strains as well?*

Prof. Peter Doherty: We don’t know of any evidence that there are different SARS-CoV-2 strains. The virus has a proof-reading mechanism (unlike influenza) and while there are minor mutations that can allow virus lineages to be tracked, we think that globally it’s essentially the same virus everywhere across the planet.

MW: *How long would a vaccine be effective as the virus mutates with time?*

Prof. Peter Doherty: First, we have to make a vaccine. Modern molecular science is incredible, and my understanding is that there are already in excess of 70 candidates in some form of pre-clinical (animal) testing, and at least one has already been injected into people. I doubt that mutation will be a major problem with SARS-CoV-2 but, as these vaccines mostly use one or the other “platform” technology where you can just “slot-in” a slightly different gene sequence, changing a successful vaccine will not be a big deal.

MW: *Data seems to suggest that SARS-CoV-2 hits men harder than women. Your comments.*

Prof. Peter Doherty: Seems to be true in some communities. Men smoke more than women do, and smoking is a major risk factor as it upregulates the ACE-2 receptor that the SARS-CoV-2 virus uses to get into cells. In general, there’s an impression that women have stronger immune systems into advanced age, but as a consequence may also have more issues with autoimmune disease than men. So far as I know, that’s not strongly based in “hard science”. There are also behavioural issues, e.g. “toughing it out” and not seeing a doctor, that put men at greater risk in many medical situations.

MW: *What is the possibility of anti-inflammatory drugs being effective in treating SARS-CoV-19?*

Prof. Peter Doherty: So far as I know, the medical advice is to avoid Ibuprofen and other non-steroidal anti-inflammatory drugs, though Panadol is evidently fine. In severe, late stage disease, we think there may be a “cytokine storm” issue, and there are promising indications that some people are being saved by blocking the pro-inflammatory cytokine IL-6. Serious, properly controlled drug trials are currently in progress. The problem though is that while these IL-6-blocking monoclonal antibodies (mAbs) are used to treat Rheumatoid arthritis patients, they are expensive to produce and in very short supply.

MW: *Do antibody tests for SARS-CoV-2 tell us anything about our immunity?*

Prof. Peter Doherty: The neutralizing antibody (NA) test is solid, but it needs a “needle” serum sample and is labour and time consuming. So far as I know, when people have been sampled sequentially through the disease, the NA response is as expected. What we need for the mass serological surveys that will tell us about background infection rates is a rapid “blood pin prick” (BPP) test that gives the same answer as the NA assay. Many such commercially produced BPP products are currently being evaluated, some look to be useless, while others are promising. Once we get to have a trustworthy mass screening assay, testing tens of thousands of people will tell us what the true incidence of this disease is in the broader community. These results will be enormously important.

MW: *How effective will an antibody-based therapy be for SARS-COV-2?*

Prof. Peter Doherty: I understand there have been some promising results with convalescent serum, and that proper trials are in progress. Many people are producing SARS-CoV-2 specific mAbs for both treatment and prophylaxis, but these will have to go through pre-clinical (likely in macaque monkeys) testing for safety and efficacy, then human trials, likely via “experimental” treatment protocols following informed consent.

MW: *What is the possibility of an anti-viral drug in the near future?*

Prof. Peter Doherty: “Repurposed” drugs like Remdesivir and hydroxychloroquine (HQ) are currently in trial, so we’re waiting for those results, though my understanding is that HQ is not as useful as some had claimed. SARS-CoV-2 specific drugs are being aggressively sought by both screening chemical libraries and by rational drug design. This could move much faster than vaccine development. Testing a drug for safety and efficacy is generally easier than vaccine evaluation.

We could have decent drugs that might be used for both treatment and prevention (like HIV PrEP) before we have

“We don’t know of any evidence that there are different SARS-CoV-2 strains. The virus has a proof-reading mechanism (unlike influenza) and while there are minor mutations that can allow virus lineages to be tracked, we think that globally it’s essentially the same virus everywhere across the planet.”

Prof. Peter Doherty

a vaccine, but that’s just a guess. The best hope is that we can have available at least two drugs that are cheap and easy to produce in mass quantities and can be used together (to prevent the emergence of escape mutants) to stop people dying from this disease.

MW: *What is the scope of herd immunity for this virus?*

Prof. Peter Doherty: Good antibody surveys will tell us a lot. Current thinking is that we will need about 70% of people to have been infected and be immune before we see herd immunity cause a massive turn-down in case incidence. The analysis will be confounded by the effects of social distancing rules, but keep a close watch on northern Italy, Spain, New York (USA), London (England) and Germany.

MW: *What will the antibiotics scenario be after the SARS-CoV-2 pandemic?*

Prof. Peter Doherty: Haven’t thought about it, but don’t see why it would be any different from now. Unlike the situation for influenza, secondary bacterial pneumonia does not seem to be a major issue for COVID-19.

MW: *What is the overall effect on the human immune system after one’s recovery from SARS-CoV-2 infection?*

Prof. Peter Doherty: Hopefully, we’ll be immune to SARS-CoV-2. Otherwise, intensive studies of the virus-specific host response are in progress, but it’s too soon to say anything about the more general effects.

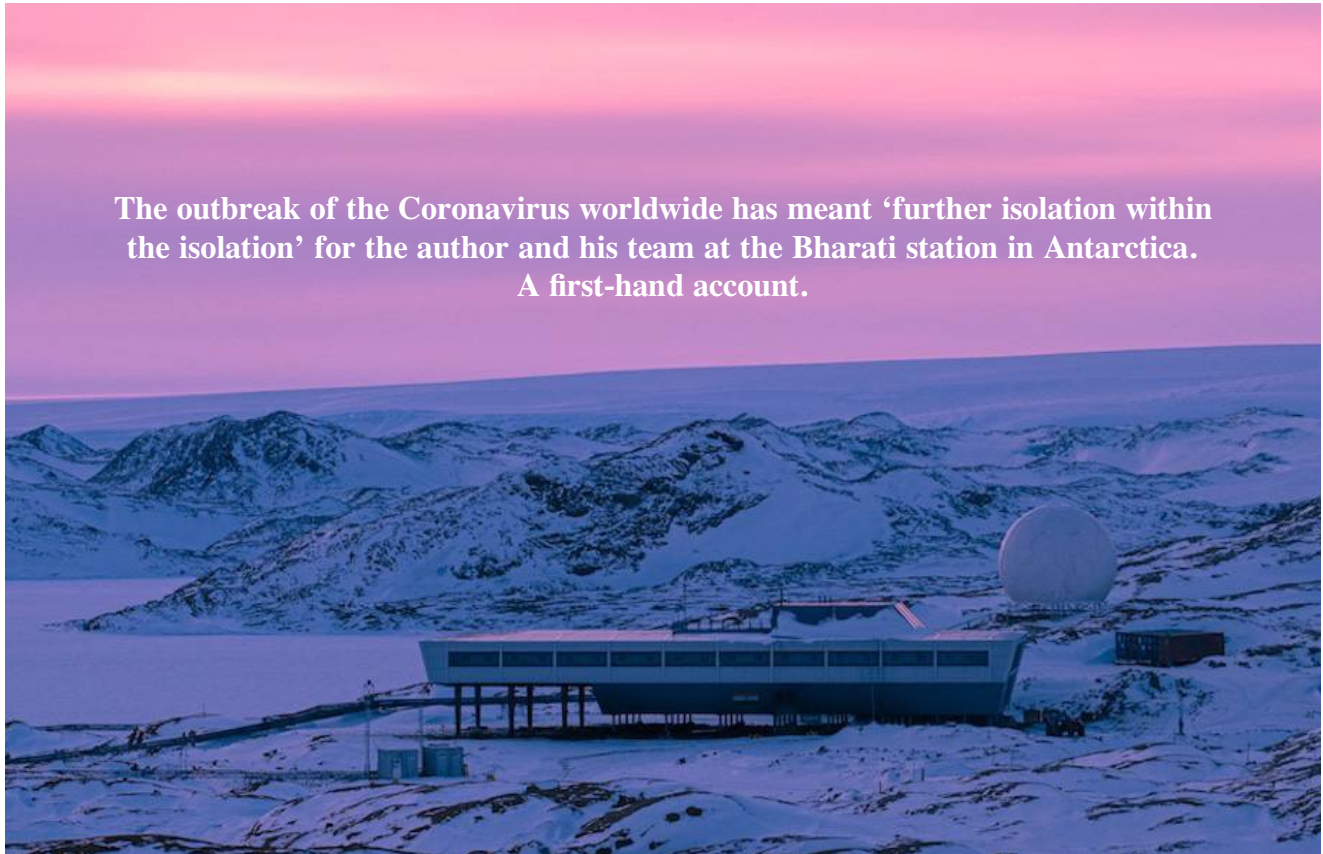
MW: *How should a country like India prepare itself for a long fight against a SARS-CoV-2 like pandemic?*

Prof. Peter Doherty: What works best is social distancing and genuine concern for all, especially for those who are in vulnerable situations. If you want to avoid contracting the disease, imagine that you are infected and that you will do everything in your power to avoid transmitting it to others. Until we have an effective vaccine and/or drugs, it’s up to each and every one of us. Otherwise, I’m not a policy person and won’t comment on those issues.

Dr Meher Wan is Scientist and Associate Editor, *Science Reporter*, CSIR-NISCAIR, New Delhi.

No 'better' Isolation: Antarctica, the only continent untouched by COVID-19

Pradeep Tomar



The outbreak of the Coronavirus worldwide has meant 'further isolation within the isolation' for the author and his team at the Bharati station in Antarctica. A first-hand account.

WHAT comes to our minds when we hear the word Antarctica? It is the coldest, driest and windiest continent on Earth. The extreme conditions of Antarctica have been a blessing in keeping the environment in a pristine shape and also making it the most isolated place to reach.

Who all are there?

Antarctica is home to around 70 active research bases belonging to different countries. These bases house more than 1000 people during the winter. They spend an entire year in isolation

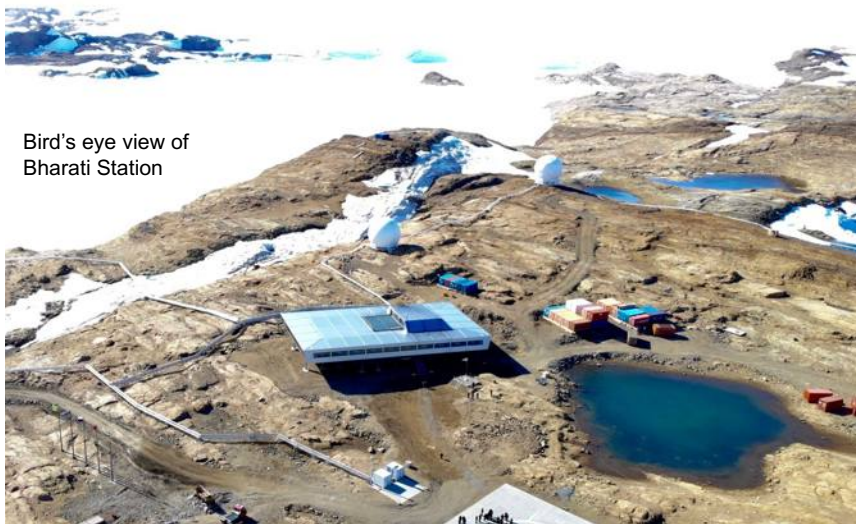
conducting various research projects on the icy continent. India is maintaining a strong presence in Antarctica since 1981. Every year members are sent to two Indian research bases – Maitri and Bharati – to spend a complete year to carry out diverse scientific studies. This year, we are 23 members deployed at the Bharati station.

Is it really a 'better' place to be safe?

Isolation, confinement and extreme climate come as a gift as soon as you put your feet on the frozen continent. There is a constant threat to life when

you are here. Vast sheets of ice are packed with hidden crevices and falling into them would make one's recovery impractical. We are already into polar winter so the temperature now can go down up to -40 degree Celsius and wind can blow as fast as 200 km/hr at our base. It will remain completely dark for almost two months during the Polar nights when the sun hides itself below the horizon.

Prior to arrival, we do get training to battle all the hardship and adversities indigenous to Antarctica. But social isolation, lack of sunlight put us at risk of developing low mood and depression.



Bird's eye view of Bharati Station

How the virus is affecting us?

Things feel uncommon this year. What is more worrisome now is the outbreak of coronavirus in India. Back in November last year when India had just begun its 39th Indian Scientific Expedition to Antarctica, the world seemed to be in its usual state. After a month into the expedition, we started hearing the news related to the spread of coronavirus. We all are now clueless about the real situation back home. Members are worried about their near and dear ones as India is moving towards Lockdown 3.0.

We had never imagined that the world would undergo a situation similar to ours. Getting stuck within the same walls and seeing the same faces every day. Our team is concerned regarding the feasibility of the next expedition and remote possibility of spending another winter in Antarctica if the situation continues to worsen in India. Such talks are now usual over dinner and are stressful for the team. Thankfully, we have enough provisions

of food and other supplies if by any means our expedition gets extended for another few months.

Antarctica under lockdown

With the worldwide spread of COVID-19, there is always an invisible threat to the White Continent. So far Antarctica remains the only continent untouched by the coronavirus. Screening of the new members entering the continent has been in place since February. Despite being the most secluded continent, Antarctica is also facing the lockdown. Routine visits and get-togethers with the neighbouring stations have been dropped. It feels as if you are further isolated within the isolation.

Nevertheless, it makes sense to take precautions to keep the continent and those residing here safe from COVID-19. An outbreak of the pandemic in Antarctica could be disastrous. Because in a remote austere medical setup it is not always possible to manage all kinds of medical

emergencies. In the freezing winter, there are no flights and it becomes almost impossible to airlift or evacuate any sick person. So the statement 'prevention is better than cure' perfectly befits the situation here.

Implications for science and research

Antarctica plays the central role in the Earth's climate. Every year several projects related to atmospheric, glaciological and geological sciences are undertaken to unearth the hidden mystery surrounding the continent. Definitely, the spread of coronavirus will retard the progression of scientific research. Interruption of ongoing projects could hamper vital monitoring of climate change indicators.

India has already called off its scientific expedition to the Arctic region, which was previously scheduled to begin from April. There are also uncertainties looming around the next Antarctic Expedition. With the continuing threat of coronavirus, it would not be possible to approve new projects for the upcoming programme. And also as a consequence of global economic slowdown, Antarctic programmes of various nations could see a dip in operational and research funding. Science conferences and workshops related to Antarctica have already been called off as many countries are facing lockdown.

Researchers are collecting vital scientific data in harsh climatic conditions.

As our country is fighting a brave battle against Covid-19, all the members of the 39th Indian Antarctic Expedition extend their firm support to all the frontline warriors. We also salute the public for cooperating in the efforts to curb the disaster. Hopefully, we will soon be able to find a cure for the virus and defeat it. See you all next year.



Researchers are collecting vital scientific data in harsh climatic conditions

Dr Pradeep Tomar is the medical officer for the 39th Indian Scientific Expedition to Antarctica. He is currently in Antarctica at the Bharati Station and will be spending a year on the icy continent. Email: pd.aiims.10@gmail.com

SHORT FEATURE

PLANTS, WARS & PANDEMICS

Aditi Ghose

DISCOVERED in 1892, yet still revealing its secrets in 2020 – viruses are full of surprises. Not quite living and having no way to multiply on their own, you might even assume them to be harmless. But one look at the graphic headlines of the past few months and you know that we are at a war with them. ‘*Battling from the Frontlines*’, ‘*Acquiring Ammunition*’, ‘*Unknown Enemy*’, ‘*Increasing Fatality*’, ‘*Unseen Invader*’, ‘*Rising Fatality*’ – the military metaphors keep pouring in. It’s almost too easy to forget that a similar battle – albeit a fiercer and longer one – has been raging for around 300 million years. That’s the battle between pretty plants and hungry herbivores.

It might seem that there can only be one winner to this war – without the ability to see hear or move, plants have a real disadvantage. So why has the battle been dragging so long? It turns out that thanks to the epic battle with animals, plants have developed vicious poisons, lethal ammunition and even cunning forms of communication. These terrifying tactics have helped



Bristlecone Pine - Oldest known woody trees in the world, some as old as 4,500 years



Giant Sequoia - Most massive trees on earth

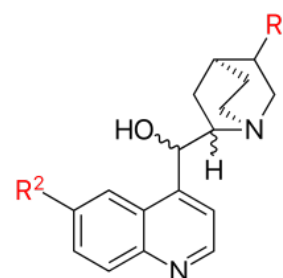
them see-off dinosaurs to caterpillars, making them the oldest, biggest and most abundant ones on earth. What’s more, the weapons in *our* arsenal today – from our foods to medicines – are the products of wars that the plants fought and won. Some of those plant-based medicines are even helping us hold fort against pandemics.

Hitching a ride on a busy travel season and our own ill-preparedness, the novel coronavirus, SARS-CoV-2, has, in a span of months, travelled to 185 countries worldwide – and still counting. A master of disguise and a cunning manipulator of genes, the virus has used our body’s defences against us – afflicting and killing indiscriminately. An effective cure and a reliable vaccine for COVID-19 are months, probably years, away. As the first line of defence, we choose to rely on the defence mechanism of plants. Clinical evaluation of chloroquine phosphate – a structural analogue of quinine, originally extracted from the bark of cinchona trees – has shown to alleviate symptoms for most patients and expedite virus antibody generation. Depending on results from

more than 10 hospitals across several provinces, the Chinese State Council on 17 February 2020 had announced that chloroquine phosphate – the anti-malarial and broad-spectrum antiviral drug, with proven regulatory effects on the immune system – can and will be used for treating COVID-19 patients.



Cinchona Flowers



Cinchona Alkaloids



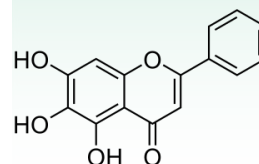
Cinchona Bark

Another plant-origin recruit to contain COVID-19 is an extract of liquorice roots – diammonium glycyrrhizinate. While liquorice has traditionally been employed against coughs, colds and disturbed digestion, its extract has been known to have anti-inflammatory activity and used in the treatment of liver damage by Hepatitis-B. Proposed as a treatment for COVID-19, in combination with Vitamin-C by Prof. Hong Ding of Wuhan University – clinical trials for this therapy have recently been approved. Patent herbal drugs – Lianhua Qingwen capsules and Radix isatidis granula, already proven useful in SARS-CoV outbreak of 2003, along with Huoxiang Zhengpi capsules are extensively being deployed to combat COVID-19. They have been known to improving symptoms such as coughing, weakness and digestive system disorders along with alleviating anxiety.

It's not the first time that we are seeking their help. Anti-viral medicines of plant origin have been resorted to during the previous coronavirus outbreaks in 2003 and 2012 and seasonal epidemics of influenza and dengue. Lycoris radiate, Artemisia annua and Linders aggregate extracts and natural products isolated from Isatis indigotica, Torreya nucifera and Houttuynia cordata have shown anti-Severe Acute Respiratory Syndrome (SARS) effects. To prevent dengue virus entry into the host and inhibit post-entry replication, another plant defense – flavone Baicalein – was employed. Besides, natural products from Pelargonium sidoides roots and dandelion inhibit virus entry and key viral enzyme activities and are strong anti-influenza drug candidates. Turns out, we have been thriving on the spoils of the plant-animal million-year war!



Isatis indigotica



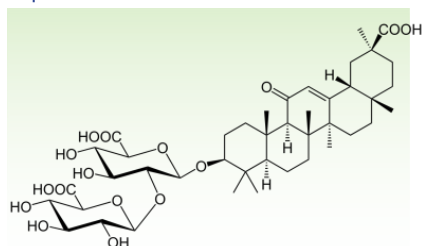
Flavone Baicalein



Torreya nucifera



Liquorice Flowers



Glycyrrhizic Acid



Liquorice Root



Lycoris radiate



Artemisia annua



Linders aggregate



Houttuynia

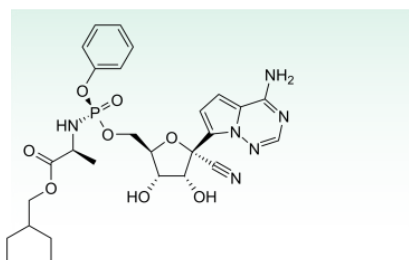


Pelargonium sidoides



Dandelion

Yet ‘war’ is clearly a misnomer for the practice of medicine. As Adina Wise, M.D., neurology resident at Mount Sinai Beth Israel Hospital (Downtown), New York warns in a Scientific American discourse, “ To adopt a wartime mentality is fundamentally to allow for an all-bets-are-off, anything-goes approach to emerge victorious. And while there may very well be a time for slapdash tactics in the course of weaponized encounters on the physical battlefield, this is never how one should endeavour to practise medicine.” In medicine, we understand, emergencies – even pandemics – are never an excuse for shortcuts. Routine drug development proceeds with researchers discovering a drug molecule with targeted potential therapeutic activity, optimizing its structure and validating its function using in-vitro experiments, followed by animal and clinical trials. In contrast, plant origin medicines and plant natural products are less clearly understood mechanistically. Yet, they have been used in clinics for hundreds or thousands of years, with well-established safe usage and documented side-effects. Once found effective, its safety already recognized, these plant-based decoctions may be immediately deployed for treating patients. In emergencies like COVID-19, this timeliness is another advantage associated with plant-based drugs.



Structure of Remdesivir - The only drug right now that may have any real efficiency in treating COVID-19

It is for this reason that epidemiologist Nanshan Zhong, credited with discovering the SARS coronavirus in 2003 and advising on the management of COVID-19 outbreak clarifies that chloroquine phosphate is not a highly effective cure

but its effects deserve attention, even though its pharmaceutical mechanism remains unclear. Nevertheless, as a complementary treatment, in combination with other potent treatments, they help to elevate recovery rates. WHO Assistant Director-General Bruce Aylward had upheld Remdesivir, an experimental drug, developed against Ebola as the only “drug right now that we think may have real efficiency”. But such drugs take time to pass clinical trials. In emergencies like COVID-19, readily available *war spoils* – potent plant products with proven efficiency and safety – buy time as the ‘*first line of defense*’.



Large locust swarms such as these can consume over 1,00,000 tonnes of food each day - enough to feed tens of thousands of people for one year.

While COVID-19 is affecting human health worldwide, pests and diseases are threatening plant health too. Food and Agriculture Organisation of the United Nations estimates up to 40% of food crops are lost to plant pests and diseases annually. Climate change and human activities not only lower yields and reduce the nutritional value of crops, they also alter ecosystems. This leads to more plant pests appearing earlier and in places they were never seen before. International travel and trade – having tripled in volume in the last decade – can and does quickly spread pests, like diseases, around the world.

The last 50 years have seen the emergence of a wide variety of coronaviruses. In all probability, they will continue to recombine, mutate and infect multiple species and cell types. Strengthening our defences, understanding its responses and

designing appropriate preventions must go a long way to contain these virions. As with human health, preventive measures – be it against viruses or pests – are far more cost-effective than dealing with full-blown emergencies. After all, plants make 80% of the food we eat, 98% of the oxygen we breathe, provide USD 1.7 trillion worth of trade in agricultural products annually while dealing with hungry pests, rising temperatures, habitat losses and an 80% reduction in beneficial insect population over the last quarter of the century. Protecting plant health is thus of vital importance for our food-security, our medicinal requirements and essentially for our own well-being – as expressed by this year’s International Year of Plant Health slogan – Protecting Plants, Protecting Life. There might never be a better time to choose *our* side in this plant-war than the pressing pandemic.



INTERNATIONAL YEAR OF
PLANT HEALTH

2020

United Nations General Assembly declared 2020 as the International Year of Plant Health

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Aditi Ghose is engaged as Education Assistant at the Birla Industrial & Technological Museum, Kolkata, one of the outreach divisions of the National Council of Science Museums (NCSM), Ministry of Culture, Govt. of India. She’s a passionate science communicator and has recently been adjudged as one of the winners of the Nature India Essay Competition 2020, in partnership with the Council of Scientific & Industrial Research, for her take on how socially-impactful science can advance and strengthen the country.

What's in a scientific name?

G. Mahesh

LIKE many scientific names, pronouncing the recently labelled *Craspedotropis gretathunbergae* and *Natrialba swarupiae* may require twisting of the tongue in a certain way. But relate these names respectively to Greta Thunberg, the young environmental activist and Dr Renu Swarup, Secretary, Department of Biotechnology, Govt of India and the utterances become easier.



Craspedotropis gretathunbergae
(Image credit: commons.wikimedia.org)

C. gretathunbergae is a newly discovered snail species in Brunei and closer home, *N. swarupiae* is a microbe somewhat similar to bacteria, an archaeon recently found in Rajasthan. Also recently, a new variety of chrysanthemum introduced by the CSIR-National Botanical Research Institute (NBRI), Lucknow, has been named *Shekhar*, after Dr Shekhar Mande, Director-General, Council of Scientific and Industrial Research (CSIR) and Secretary, Department of Scientific & Industrial Research, Govt of India.

William Shakespeare had famously said, “What’s in a name? That which we call a rose by any other name would smell as sweet.”

That might be so, but in the scientific world, it is essential to accurately identify the millions of organisms on the planet

by their universal scientific names. These are names that the scientific community across the world recognises rather than the myriad common names that vary widely across languages and countries.

It was Carl Linnaeus, the Swedish botanist, zoologist and physician, who in the 18th century devised the binomial system of nomenclature – a system where a scientific name has two parts, the genus name and the species name. For example, the genus *Mangifera* and the species *indica* together identify the Indian mango as *Mangifera indica*. And yes, scientific names are italicised. The first letter of the genus name is capitalised and the species name is in small letters. Many times, the species name is also followed by the variety or the cultivar name. This is common for flowers like roses that come in many varieties or, chrysanthemums where new hybrids or cultivars like *Shekhar* are introduced.



The naming itself is done by the discoverer of a species or the creator of a new cultivar. When named after an individual, it usually is as a mark of respect, love or affection. And many species can be named after one individual. For example, Alexander von Humboldt, the Prussian polymath has the most number of species named after him. In fact, plant and animal lovers have given both scientific and common names after Humboldt, such as *Spheniscus Humboldt* – the Humboldt penguin and *Lilium humboldtii* – Humboldt’s lily. The famous and much-loved naturalist David Attenborough also has lent his name to many species. *Nepenthes attenboroughii*, a species of pitcher plant and *Trigonopterus attenboroughi*, a species of beetle are a couple of Attenborough namesakes.



Spheniscus Humboldt
(Image credit: commons.wikimedia.org)

It is not just scientists that species have been named after, but scientific epithets have been lent by famous personalities as well. Some of them are Pope John Paul III, George W. Bush, Kate Winslet, Arnold Schwarzenegger, Shakira, Nelson Mandela, Adolf Hitler, Barack Obama, Michelle Obama, Bill Clinton, Al Gore, Rudyard Kipling, Beethoven, Buddha, Charlie Chaplin, Che Guevara, Steven Spielberg, Brad Pitt, Dalai Lama, Madonna, Bill Gates, Shakespeare, Abraham Lincon, Jennifer Lopez, Michael Jackson, Mikhail Gorbachev, Marilyn Monroe, and many more.

Some famous Indians whose names have been attributed to species include A.P.J. Abdul Kalam, Jayalalitha,

Janaki Ammal, Indira Gandhi, P.M. Bhargava and M.S. Swaminathan. Researchers have also named organisms after their mentors. One such example is that of a group of researchers naming a bacterium *Pradoshia eiseniae* in honour of their beloved mentor late Pradosh Roy, an eminent Indian microbiologist.

For all the naming of organisms out of love, honour and respect, there are also instances of spiteful and scornful naming too, going back to Linnaen times and in fact to the master nomenclator Linnaeus himself. One of the oft-repeated stories of spiteful naming is that of *Sigesbeckia* – a pungent weed, named so by Linnaeus after fellow-botanist Johann Georg Siegesbeck, who was a strong critic of Linnaeus’s classification system.



Sigesbeckia orientalis
(Image credit: commons.wikimedia.org)

Yet another infamous naming by Linnaeus is that of the bug, *Aphanus rolandri*. The story goes that Daniel Rolander, a student of Linnaeus fell out with his teacher and the angered Linnaeus blacklisted Rolander and named the bug *Aphanus rolandri* after him. Aphanus in Greek means obscure or dubious.

This does not mean that today one can go on and give any abusive, spiteful or scornful names. There are international conventions that need to be followed when naming organisms. As per the code of ethics of International Code of Zoological Nomenclature (ICZN), “No author should propose a name that, to his or her knowledge or reasonable belief, would be likely to give offence on any grounds.” Other naming conventions include the International Code of Nomenclature for algae, fungi, and plants, International Code of Nomenclature for Cultivated Plants (ICNCP) and International Code of Nomenclature of Prokaryotes (ICNP).

Naming and classification of viruses are a bit different from other biological organisms because of the pseudo-living nature of viruses. Viruses are not living things but have some biological characteristics such as being able to rapidly reproduce within host cells and also being able to mutate. The naming of viruses does not follow the binomial system of nomenclature like plants, animals, bacteria, fungi, etc., and virus names as such do not follow a uniform format.

As per Rule 8 of the naming conventions framed by the International Committee on Taxonomy of Viruses (ICTV), “no person’s name shall be used”. And numbers, letters and their combination can be used to construct virus names. So, we have the near-global emergency causing COVID-19 virus, where COVID stands for Corona Virus Disease, the disease that COVID-19 causes and 19 representing the year 2019 when the virus was discovered. Of course, there are virus families, subfamily, order, etc. And there has been an ongoing debate for the last many years if viral taxonomy should also switch to the standardised binomial system of nomenclature as followed for other organisms.

The naming of organisms can also be after places and properties, like *Indibacter alkaliphilus*, the bacteria named so, as it was discovered in an alkaline habitat in India. Scientific names may also be based on vernacular names such as *Michelia champaca*, named after *champa* in Hindi. Then there are the shortest and longest scientific names. Shortest being *Ia io*, the great evening bat and *Yi qi*, a Jurassic period dinosaur. The longest scientific name, hold your breath, *Parastratiophemyia stratiophemyioides*, belongs to a wasp-like-fly that is a native to Thailand.

While the scientific name is generally distinct from the common name, *Aloe vera* is one of the rare examples where the scientific and common names are the same.

Can mistakes happen during the naming of a species? Are scientific names sacrosanct? Can scientific names that have been in use be changed later? The answers to the three questions are, yes. Species that have been named previously can get mistakenly named again. And when it happens, it is corrected by reversing the wrongly given name. Sometimes, it is necessary to split an existing genus and give a name to the new genus.

For example, all small cats once belonged to the genus *Felis*. Later they were segregated into multiple genera and

bobcats, a North American cat known by the scientific name *Felis rufus* was changed to *Lynx rufus*. Early scientific literature still has bobcats named as *Felis rufus*, its former name.

Another interesting case, this of a merger, is of *Dryandra*, a small tree genus found in Australia. The genus *Dryandra* was merged with another genus *Banksia* when molecular and morphological studies showed beyond doubt that *Dryandra* had descended from *Bankasia* and hence cannot be a separate genus as it was initially grouped and named.

In spite of the international conventions and codes being in place for naming mammoth mammals to microscopic viruses, bad taxonomic practices, unscientific methods and professional misconduct are occasionally seen in naming organisms leading to what is called taxonomic vandalism. The most infamous case of taxonomic vandalism reported is that of the Australian snake catcher Raymond Hoser who has named and renamed hundreds of genera of snakes and lizards without adequate scientific basis and even naming the same taxa twice over.

Understandably, renaming without reason, unscientific naming and multiple naming create confusion and chaos which goes against the very principles of scientific nomenclature.

The Linnaean system of binomial nomenclature has been around for more than 250 years now. Is it the perfect system of naming organisms? Not really, says the International Society for Phylogenetic Nomenclature (ISPN) that came into being in 2004. The ISPN propounded a new system of classification called the PhyloCode. This new system of classification is structured to replace the Linnaean system of classification with the phylogenetic system of classification. The PhyloCode categorises organisms by their evolutionary development and diversification rather than the characteristics or traits that the Linnaean system follows.

It is difficult to estimate how many species dot the earth. Estimates vary from 8.7 million to one trillion. Of this, only about 1.3 million have been identified and described so far. That leaves millions of organisms still to be identified, named and explained.

So, even as taxonomists battle out the naming conventions, step out, find a new species and give it a name. And if you can’t find a new species, create a new cultivar and give it a name.

By the way, not all scientific names are necessarily tongue twisters. *Aha ha*, the Australian wasp got that simple and rather intriguing name because the entomologist who discovered it exclaimed, *Aha* and his fellow entomologist uttered, *Ha*. There is also another name that easily rolls off the tongue. It is *Leonardo davincii*, a moth found in Sudan.

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CSIR's Mission to Combat COVID19

The Council of Scientific and Industrial Research (CSIR) has been leading the fight and contributing extensively to overcome the crisis arising from the deadly coronavirus outbreak. The May issue of *Science Reporter* outlined several key achievements of CSIR's fight against COVID-19. Here are a few more.

Coverall Suit to Combat COVID-19

CSIR-National Aerospace Laboratories (CSIR-NAL), Bengaluru, along with MAF Clothing Pvt. Ltd, Bengaluru, has developed and certified polypropylene spun laminated multi-layered non-woven fabric based Coverall to ensure the safety of Doctors, Nurses, Paramedical staff and Health Care workers who are working round the clock to fight COVID-19.

The Coveralls have gone through stringent testing at SITRA, Coimbatore, and have been certified for use. CSIR-NAL and MAF have plans to augment the production capacity to about 30,000 units per day within four weeks. The major advantage of these Coveralls is their highly competitive price. The import content is also negligible.



HCARD — Robotic Device for Frontline Healthcare Warriors

CSIR-CMERI (Central Mechanical Engineering Research Institute), Durgapur, has developed a “Hospital Care Assistive Robotic Device” to safeguard the healthcare workers by reducing their exposure to the infected patients directly. The device helps healthcare workers maintain physical distance from COVID-19 patients.

The robotic device possesses various features including navigation, drawer activation for providing medicines and food to patients, sample collection and audio-visual communication. It can be controlled and monitored by a nursing booth with a control station. The robot works with both automatic as well as manual modes of navigation.



Trial on Mycobacterium W (Mw)

CSIR has been granted approval by the Drug Controller General of India (DCGI) to conduct trials on an approved immunomodulator, Sepsivac[®], to test its efficacy against COVID-19. The drug contains heat-killed Mycobacterium W (Mw), to enhance innate immunity of the body to limit the spread of COVID-19 infection. It will also help to fasten the recovery of infected patients. Sepsivac[®] drug is used to treat patients with gram-negative sepsis and is also effective for leprosy patients. There are similarities between the clinical characteristics of coronavirus patients and gram-negative sepsis because of which it may hold some promise.

CSIR Identifies top 25 Drugs for Repurposing

To make drugs available for corona patients in India, CSIR is working on the repurposing of 25 drugs/drug candidates for COVID-19. Hyderabad based CSIR-Indian Institute of Chemical Technology (IICT) has developed a convenient and cost-effective synthetic process for Favipiravir, an inhibitor of viral RNA polymerase and that has emerged as one of the most encouraging drugs. The technology has been transferred to Cipla which will approach the Drugs Controller General of India (DCGI) for approval of Favipiravir to be launched in India as Ciplenza.

Herbal Decongestant Spray for Mask by CSIR-NBRI

The most common problem of wearing a mask for a long time is suffocation. Masks can cause congestion in the respiratory system. CSIR-National Botanical Research Institute (NBRI), Lucknow, has developed a “Herbal Decongestant Spray” that removes the mucus or cough thus clearing the windpipe and congestion. The spray has been formulated as per the guidelines of the Ministry of AYUSH. The Institute is planning to transfer the technology for commercial production.



CIMAP's CIM-Paushak and Herbal Cough Syrup

CSIR-Central Institute of Medicinal and Aromatic Plants (CIMAP), Lucknow, has developed two herbal products, CIM-Paushak and Herbal Cough Syrup — that can boost immunity and help in easing the dry cough symptom linked with COVID-19. The two effective, cheap and safe products have been formulated as per the guidelines from the Ministry of AYUSH. The products have been formulated using twelve valuable herbs including Puranva, Ashwagandha, Mulethi, Harad, Baheda and Sataver.



In Brief

- CSIR laboratories across the country have helped support their state governments by sharing their COVID-19 samples testing load. A total of 2152 samples were tested across 5 CSIR labs (IIIM – 758, IMTECH – 727, NEERI – 301, IHBT – 222 and CCMB – 144). In addition, CSIR-CFTRI has helped the state government hospitals by providing their RT-PCR machines to conduct the tests.
- CSIR-IGIB had developed a cost-effective, portable and rapid paper strip based test kit called FELUDA. CSIR and Tata Sons have now signed an MoU for licensing the technology for scale-up and deployment in usable kits.
- CSIR labs are also working towards the development of Lateral Flow Devices for rapid and reliable detection of coronavirus at primary health centres and testing facilities. CSIR-IITR, IMTECH, CSIO, CFTRI, NIIST and CEERI are involved in designing such a point of care device.
- CSIR-CDRI, Lucknow, has joined hands with the King George's Medical University (KGMU) for development of a vaccine for COVID-19. CDRI is already collaborating with the KGMU in three research projects – molecular research to know the reasons for disease causation; finding treatment methodologies and the third to develop a vaccine for the virus.
- CSIR-IICB, Kolkata, has established a new 'Epidemic Immune Monitoring' lab indispensable for the CSIR Plasma Therapy Trial. CSIR has taken a major initiative to pursue convalescent plasma therapy. The West Bengal State Govt approved the proposal of CSIR-IICB for Convalescent Plasma Therapy programme on April 9, 2020.
- CSIR has submitted 53 genome sequences of the virus to the GISAID (Global Initiative on Sharing All Influenza Data) and is planning to submit 450 more genome sequences. The sequencing will help in understanding the origins of the virus which will further aid in developing vaccines.
- CSIR is exploring a native herb as a biological medicine or “phytopharmaceutical”, which is already being tested as medicine for dengue, for its efficacy to combat COVID-19. CSIR is hopeful to get approval from Drug Controller General of India (DCGI) to conduct a clinical trial on humans of the herb, which is used as native medicine in the country.
- CSIR through its NMITLI programme has approved a project towards the development of human monoclonal antibodies (hmAbs) that can neutralize SARS-CoV-2 in patients. This project on the generation of neutralizing human monoclonal antibodies as a therapeutic strategy will be implemented by a multi-institutional and multi-disciplinary team. The team comprises of academic institutes and industry with participants from NCCS, IIT-Indore, PredOmix Technologies and Bharat Biotech International.

International Workshop

“Air Pollution and Public Health: Challenges and Interventions”

AIR pollution is recognised as one of the top five causes of mortality linked to respiratory and heart diseases worldwide. According to a WHO report, air pollution leads to 7 million deaths worldwide with a total of 4.3 million deaths linked to household air pollution and 2.7 million related to ambient air pollution.

To focus on the issue, the Centre for Science & Technology of the Non-Aligned and Other Developing Countries (NAM S&T Centre), New Delhi, jointly with Sri Venkateswara College, University of Delhi organised an “International Workshop on Air Pollution and Public Health: Challenges and Interventions” at Hotel Radisson Blu, Dwarka in New Delhi, India, during 5-7 February 2020.

There were 78 participants in the workshop including 13 experts and professionals from developing countries *viz.*, Bhutan, Cambodia, Cuba, Egypt, Indonesia, Iran, Malaysia, Myanmar, Nepal, Palestine, Sri Lanka, Zambia, Zimbabwe; and 65 eminent medical professionals, scientists, government officials, industry representatives as well as students from the host country, India. Prof. (Dr) Randeep Guleria, MD, DM [Professor & Director, All India Institute of Medical Sciences (AIIMS), Delhi] was the Chief Guest at the workshop.

The three-day International Workshop had two Panel Discussion Sessions and eight Technical Sessions in which 32 papers were presented. Some of the themes covered in the Panel Discussion and Panel Lectures included:

- Air Pollution: Know your Enemy — Insights from Around the Globe
- Air Pollution: A Burden on One’s Health
- Indoor Air Pollution: A Devil at Home?
- Air Pollution & Respiratory Diseases: Turning Acute to Chronic
- Alarming Rise of Cancer: Is Air Pollution a Contributor?

- Impact of Air Pollution on Reproductive Health
- Mitigation Strategies and Role of Public-Private Partnership
- Recommendations for Sustainable Solutions

The Inaugural Session commenced with a welcome address by Dr P. Hemalatha Reddy, Principal, Sri Venkateswara College, University of Delhi which was followed by an address by Dr Amitava Bandopadhyay, Director General, NAM S&T Centre. He presented the genesis of the event and also briefly described the activities of the Centre (an Inter-governmental Organisation) and highlighted the need for affirmative action on mitigation of air pollution by collaboration and cooperation between various countries and how the NAM S&T Centre could facilitate in achieving these goals.

The Chief Guest Prof. (Dr) Randeep Guleria, Professor & Director, All India Institute of Medical Sciences (AIIMS), New Delhi, shared his professional experience as a Doctor with his research focus on Pulmonology, Respiratory and Sleep Medicine and stated that the biggest challenge of air pollution is that it is an invisible danger and it is hard to fight something that one cannot see, touch, feel or taste. The session concluded with the Vote of Thanks by Dr Vartika Mathur, Assistant Professor, Sri Venkateswara College, University of Delhi, which was followed by an official Group Photo Session.



Dr Amitava Bandopadhyay



During the Concluding Session, a 'New Delhi Resolution' with the following set of recommendations was extensively discussed and unanimously adopted by the participants:

1. Appropriate policies should be adopted and programmes initiated to control air pollution resulting from emissions of oxides of carbon, sulphur & nitrogen; hydrocarbons and particulate matter, from stationary and mobile sources to achieve acceptable levels of ambient air quality.
2. Efforts should be made to have continuous monitoring systems of primary and secondary pollutants and their sources to provide precise information about the level of air pollution in a region-specific manner, including hotspots, to get a clear idea about the intensity and magnitude of the problem.
3. Member countries should share information about emissions of different categories of air pollutants from various sources.
4. In order to precisely establish the cause-effect relationship, efforts should be made to continuously monitor and record seasonal fluctuations in air pollution levels and correlate with increased incidents of associated health issues.
5. Governments, industries as well as research and healthcare institutions should encourage trans-disciplinary, holistic research to study the effects of air pollution on human, animal and plant health.
6. The understanding of the concept of 'One Health' should be promoted especially in the context of air pollution.
7. Special emphasis should be given to conducting in-depth analysis of the sources, types, causes and effects of indoor and ambient air pollution.
8. Capacity building programs, workshops and training sessions should be conducted to sensitize people about the causes and harmful effects of indoor and ambient air pollution.
9. Governments should encourage educational institutions to adopt pedagogical tools in the curriculum in the environment and climate change to increase awareness and sensitize students on the harmful effects of air pollution and their role in minimizing the effects.
10. Local health workers and medical practitioners should be encouraged to be involved in epidemiological programs, to create a database of various health issues related to air pollution.
11. Governments should encourage and fund start-ups and researchers engaged in designing environment-friendly solutions in sectors such as transportation, household cooking, construction, etc. to minimize the emission of air pollutants.
12. Appropriate emission control strategies should be adopted on national and international basis, which may include emission standards for various categories of polluters, within a legal framework, and other effective and efficient means of reducing the pollution levels.
13. Internationally coordinated research and development programmes should be supported and undertaken aimed at better understanding of the effects of air pollution on humans and the environment, and improving technologies for fossil fuel combustion and control of pollutant emissions.
14. Governments in NAM and other developing countries should encourage the use of biofuels and other sources of renewable energy. The focus should also be directed towards waste management and biotreatment of polluted environments.
15. All major industrial and infrastructure projects should undergo a human health impact assessment as a part of the approval process.
16. Industries should be mandated to adopt 'Cleaner Technologies' in their production processes to reduce air pollution at source. Industries should be encouraged with incentives to implement 'Process Optimization' and 'Process Integration' for mitigation of air pollution.

Hands-on Training for *Young Researchers*

Kanchan Puri and Ritesh Joshi



Herbarium techniques

THE Indian Himalayan Region (IHR) is globally recognised as one of the biodiversity hotspots (known for its sensitive ecosystem), representing tropical, subtropical, temperate, subalpine vegetation & alpine forest types. It holds a special position due to its unique culture, tradition, and value systems.

This hands-on training provided basic exposure on (i) methods of field surveys for ecology and vegetation science data collection, analysis and interpretation; (ii) herbarium specimen collection, preparations, accessioning and the record-keeping; and (iii) effective use of remote sensing & GIS and statistics for analyzing field datasets.

The twelve-day course provided a platform to the young researchers for improving their understanding of on-field approaches for data generation, information collection and contemporary approaches in exploration/assessment in the mountain region, understanding the forest functioning & dynamics, its related phenomenon in the region.

The training programme was held at the G.B. Pant 'National Institute of Himalayan Environment', an autonomous institute of the Ministry of Environment, Forest & Climate Change, Government of India from 24 February to 6 March 2020.

The inaugural session was graced by Dr R.S. Rawal, Director of the Institute and Dr G.C.S. Negi, Scientist. Course instructors were Dr K.C. Sekar, Scientist and Dr Vikram Negi, Scientist; eminent resource persons included Dr Rajiv Pandey, ICFRE; Dr S.D. Tiwari, Kumaon University; Dr G.C. Joshi, Prof. Uma Melkania G.B. Pant University of Agriculture & Technology, Dr Randeep Singh, Asst. Professor, AMITY, Dr K.V. Satish, Dr Subodh Airi from GBPNIHE. The training brought around 30 participants from Almora, Jammu, Gujarat and Delhi across 10 organisations. There were sessions on techniques for plant preservation, valuation of ecosystem services, C Stock estimation, REDD+.



Vegetation assessment



Information Education Communication

The forum gave the participants that extra edge on long term ecological monitoring which is required in the preparation of conservation plans, and practical approach beyond the classroom. Insights were provided on rural technology (developed at minimal cost using locally available raw material) being used by people for their livelihood.

In the past few years, many Himalayan inhabitants have found a new opportunity to host tourists as guests in their homes, commonly known as 'Community Based Ecotourism' which offers local culture, cuisine, and interaction with the community for a reasonable price.

This concept is also becoming an important source of livelihood for the Himalayan communities. The participants were apprised about this concept also.

Application of statistics in vegetation assessment was also taught as ecological data is usually collected with intensive fieldwork and needs to be scientifically presented, analyzed and interpreted to address the research question. The number of analytical methods is available in a variety of statistical software packages for analysing the data. Use of statistics is very important to improve the quality of research.

The participants got familiar with design of experiments for planning and implementation of the research, sampling methods for improved data collection, application of GIS & Remote Sensing. The geospatial tools provide the means through different platforms to present, analyze and model (future predictions and scenario building) the information for much better understanding by the policymakers for informed decision making.

Another interesting topic highlighted during the course was the importance of traditional knowledge possessed by the villagers in the region. There is a need for documentation of this traditional knowledge in terms of the importance of medicinal plants in the Himalayas and keeping

in mind the sustainable utilisation of such resources. On the last day of the workshop, as a part of Swachh Bharat Abhiyaan campaign, participants were involved in the cleaning drive around the Kosi watershed.

The course offers young researchers an opportunity to strengthen their research skills through participatory, hands-on classroom and field activities. It also enhances their professional skills for documentation of their research.

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Learning to Learn

Jagriti Natraj

THIS contribution is a true and unbiased reflection of a sixteen-year-old on how even a short summer internship, experiments in learning and some insightful interactions with scientists and domain experts at an institute can impact her life and career choices. Through experiments we also find out that the learning should be made fun for better impact. Hence, learning to learn is a critical skill.

Let me give you an idea of what I am trying to talk about. On 3 June 2019 this class XI student (yours truly) was trying to decide, what should she spend the rest of her life doing? Medicine? Engineering? Which subjects should she take? Is Mathematics required?

Twenty-five days later, on 28 June 2019, after a short stint as an Intern, I had already made up my mind I was going to become a neuroscientist. There is more to Biology than just medicine. Mathematics is an integral part of understanding nature and it's magic.

Do we need to say more?!

Confused and clueless earlier, how did I get so much clarity in just a few days? This was possible due to the time I spent at the CSIR-Institute of Genomics and Integrative Biology (CSIR-IGIB). It changed my vision of the world and unlocked a kaleidoscope of possibilities. It was here that I discovered a plethora of diverse and interesting fields, ideas I hadn't ever conceived. And here is the story how it all transpired.

On day one, as I entered the Institute and passed by the fascinating labs with equation-smeared glasses, I felt as though I had entered a Sci-Fi

movie. A senior scientist introduced me to several new concepts and some eye-opening research. I got to know that the hydrophobic properties of a lotus leaf find application in modern-day waterproofing. Then there is the golden ratio seen in the shells of snails. There are fish that can live on land (Mudfish)! Our tastes are hard-wired in our genetics. Ayurveda – the ancient system of medicine – when validated by science, surprisingly brings us to the goal of personalised medicine. Elephants, whales and naked mole rats, evolutionarily close to humans, have inbuilt mechanisms to save themselves from cancer. Perhaps a cure to this fatal disease could be found by adapting their mechanisms to humans!

With this exposure to new ideas, I found that my understanding of the world and the sciences had expanded and grown. Gradually, I realised that I was especially interested in the working of the human brain and its role in our everyday activities.

I also found that the mechanism of studying itself intrigued me the most. I loved this new way of learning and found that studying can be informative, exciting and fun; all at the same time! It needn't be done as a boring chore, just for marks.

This set me wondering – why have I suddenly started enjoying studying? I could remember most of the things that I had read out of *curiosity*, while it wasn't the same case with school textbooks!

Turns out, curiosity is more powerful than we think. The mesolimbic circuit in the brain gets activated when we're curious, turning the information we want to seek into

a reward. It is like getting a bar of chocolate for finishing your workout. When we're curious about what we learn, our brain regions that control attention, memory and emotions get activated due to this reward circuit – thus changing the whole experience of learning.

Curiosity might be the difference between enthusiastically attending a class that evokes interest rather than just sitting through a boring or technical class. Our expanded potential to imbibe knowledge when we're curious and interested is phenomenal.

Now, I had to test this hypothesis, so I turned my brother and father into my subjects and tried to get them to read about Gravitation. I gave both of them different passages based on the same information, only that one was better written and began with a question to generate some curiosity. I found that just an opening question wasn't sufficient to induce enough curiosity to get through the remaining 150 words of technical terms. So, I modified the passages, now backing each fact by curiosity-driven questions relating to everyday life. Even for someone who had read about Gravitation in great detail, this new version of information was much more enjoyable!

I aim to study these two models with school children so as to make learning a fun experience. I want to understand the neuroscience behind it in order to better the most crucial 14 years of any child's life. It is then that children would develop an interest in education, not just study to get marks. It is important to develop a deeper understanding of the world and just

The two passages on Gravitation as a test of my hypothesis

Passage 1

Gravitation

Gravity or gravitation, is a phenomenon by which all things with mass or energy are brought toward (or *gravitate* towards) one another. Gravity is responsible for many of the large-scale structures in the Universe. Planets, stars, galaxies and even light are brought towards one another due to gravitation. The earth is in an orbit around the Sun due to its gravity. Gravity has an infinite range and it is an invisible force, although its effects become increasingly weaker on farther objects. Gravity is well approximated by Newton's law of universal gravitation, which describes gravity as a force which causes any two bodies to be attracted to each other with a force directly proportional to the product of their masses and inversely proportional to the square of the distance between them. Gravity is the weakest of the four fundamental forces of physics, approximately 10^{38} times weaker than the strong nuclear force, 10^{36} times weaker than the electromagnetic force and 10^{29} times weaker than the weak nuclear force. On Earth, gravity gives weight to physical objects. You exert the same gravity on earth as it does on you, however since your mass is less than the earth's, it doesn't have any effect. The earliest instance of gravity in the Universe possibly developed during the Planck epoch (up to 10^{-43} seconds after the birth of the Universe), possibly from a primeval state - such as a false vacuum, quantum vacuum or virtual particle.

Passage 2

Guaranteed weight loss without exercise

Get up and jump – why do you land on the ground and not float into the air? We land on the Earth; simultaneously the earth is revolving around the Sun? How? Why?

Gravity! This invisible force pulls objects towards each other. Earth's gravity pulls you to the ground when you jump. Then again, the Earth is falling towards the Sun perpetually due to gravity, which is why it isn't going off in a straight line. So it revolves around the Sun in a curve (orbit). Why is that so important? Due to this gravitational pull we are at a comfortable distance to enjoy the sun's light and warmth. Gravity also holds down our atmosphere from which we get the air we need to breathe. It holds our world together and we couldn't have lived on the Earth without it. Such profound effects, yet gravity is the weakest force among all the 4 fundamental forces of physics; it's weaker than the weak nuclear force!

Now if all objects exert gravitational force, are you pulling the Earth like it pulls you? Earth's gravity comes from all its mass. You exert the same gravitational force on the Earth as it does on you. Since Earth is so much more massive than you, your force doesn't really have an effect on planet. In fact gravity is what gives you weight. If you were on a planet with less mass than Earth, you would weigh less than you do here. Eureka! Hop onto the Space X weight loss expedition to the Moon. Guaranteed 83% weight loss without exercise.

So what is the relation between objects and their gravity? Objects with more mass have more gravity. But gravity gets weaker with distance. Thus the closer objects are to each other, the stronger their gravitational pull is. Who knew an apple falling off the tree could prompt such a significant discovery, leading Sir Isaac Newton to form the Universal Law of Gravitation.

That is how gravity was discovered but when was the earliest possible instance of gravity? It was possibly during the Planck epoch (up to 10^{-43} seconds after the birth of the Universe). So the next time you see a tide in the ocean or a star in the night sky, know that gravity is the force behind them. Keep looking – maybe the next ground breaking discovery is made by you!

not become better at memorization.

I want to find out how curiosity actually extends its impact in the domain of primary education, whether it helps make studying a less monotonous and more exciting journey. Formal education should be like the fun learning I did at IGIB.

It was here that I was exposed to a wide array of thought provoking ideas. I stepped out of the comfort zone of what I knew, scanning the world through a fresh perspective. This outlook has in turn remodeled the concept of learning into a powerful

and interesting form of awareness.

I have learnt to look for the *why* in often overlooked simplicities of nature and in this process found the *why* of gaining knowledge.

So the next time you're taking a walk and you see the beautiful trees, ask yourself why their branches are spread out the way they are. When you write on a piece of paper, think of the force enabling you to do so. When you look at a rainbow, find out how it forms. For it is this *why* that has led to progress, both in Science and as a species.

Acknowledgements

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Ganga Aamantran Abhiyan The National Mission for Clean Ganga

The largest-ever social and public awareness campaign covering 2500 Kilometres stretch of river Ganga

Sonali Nagar



From L to R: Shri U.P. Singh, Secretary, Ministry of Jal Shakti; Shri Gajendra Singh Shekhawat, Minister for Jal Shakti; Shri Amit Shah, Home Minister; Shri Rattan Lal Kataria, Minister of State for Jal Shakti; and Shri Rajiv Rangan Mishra, DG, NMCG

THE National Mission for Clean Ganga (NMCG), Jal Shakti Ministry, Government of India, organised “Ganga Aamantran Abhiyan”, a unique, pioneering and historic exploratory river rafting and kayaking expedition from Devprayag to Ganga Sagar from 10 October 2019 to 12 November 2019 to spread awareness about river Ganga rejuvenation and water conservation.

The formal flag-in ceremony for “Ganga Aamantran Abhiyan” was organised on 13 March 2020 at the Ashok Hotel, New Delhi. Hon’ble Union Minister for Home Affairs, Shri Amit Shah was the Chief Guest and other dignitaries including Shri Gajendra Singh Shekhawat, Minister for Jal Shakti; Shri Rattan Lal Kataria, Minister of State for Jal Shakti and Social Justice & Empowerment; Shri U.P. Singh, Secretary, Ministry of Jal Shakti; and Shri Rajiv Rangan Mishra, DG, NMCG, also graced the occasion.

As a part of Namami Gange project, the expedition was flagged-off by Hon’ble Minister of Jal Shakti, Shri Gajendra Singh Shekhawat on 7 October 2019 in New Delhi. The thirty-four-day journey covering five states and connecting millions of people was the first and longest ever campaign by NMCG to raft across the entire length of the Ganga River including various adventurous sporting activities spreading the message of river restoration and conservation on a huge scale. The expedition experienced various aspects associated with the river and also drew attention towards the ecological challenges being faced by the river.

Ministers and administrators from central Govt and other state Govt of five basin states including Uttarakhand, Uttar Pradesh, Bihar, Jharkhand and West Bengal, MPs, MLAs, Urban local bodies, NGOs, Schools, Colleges, Universities, Ganga Vichar Manch, Ganga Praharis,

Ganga Mitras, Ganga Taskforce, etc. participated at different locations of the journey.

However, the core team included Wing Commander, Paramveer Singh, Squadron Leader Dipti B. Koshthi (Jaguar engineer), Sergeant Srihari Sarripilli (Open water swimmer), Sergeant Johny Vj (Open scuba diver and aqua parasailing instructor), Corporal Amrendra Vats (Medical assistance) and Corporal Vickey Takas (Multiple records in swimming) from Indian Air force (IAF); Havildar Rajesh Kumar (Adventure sports enthusiast) and Havildar Devendra Singh (Adventure sports enthusiast) from Indian Navy; PO Bikesh Kumar, Indian Navy; Ms Suhasini Shekhawat (Mountaineer, international shooter and rafter); besides members from NMCG, National Disaster Response Force (NDRF) and Scientists from Wildlife Institute of India (WII) and CSIR-Indian Institute of Toxicology Research (CSIR-IITR), Lucknow.

The expedition was led by Wing Commander Paramveer Singh, IAF, who made a record by swimming the entire length of the Ganga from Devprayag to Gangasagar in 2015. The team undertook various activities and extensive public awareness campaigns with 34 stops at various locations along the route. They also organised mass cleanliness drives on the Ghats and streets, plantation drives, etc. and interacted with students of the villages and cities conveying the message of river rejuvenation.

The Flag-in ceremony began with the screening of a short movie on “Namami Gange” by NMCG.

Shri U.P. Singh, during his welcome address shared his experiences during the expedition and said that this mission was a unique effort to spread awareness and motivate people to conserve the river Ganga.

Shri Amit Shah, addressing the gathering said, “Ganga has special importance in India’s spirituality, knowledge, culture and economy.” He said we treat river Ganga as our mother, yet, India couldn’t have cared for the river as it ought to have. He further highlighted the increasing load of human activities and industries on the banks of the



A display about the expedition



During the closing of flag

river throughout the years which led to its contamination in various forms. He said that for thousands of years it was believed that by taking a dip in Ganga water, all sins vanish, but due to its pollution, people think twice before taking a dip in river water. Ganga lost its ‘Nirmal, Aviral’ (clean and uninterrupted) stream because of overuse of water and its contamination, he added.

Discussing the main focus of the mission he said that this mission was not just an attempt to create an infrastructure, it was not just a campaign to stop pollution, but the main aim of Namami Gange was to spread a culture of conserving and preserving the Ganga in its ‘Nirmal and Aviral’ status for future generations and that nobody contaminates it again in future.



During the release of the book



Shri Amit Shah addressing the gathering

The Minister appreciated the endeavours of the Jal Shakti Ministry in taking the PM's vision forward and carrying out laudable efforts in reviving the Ganga in a short span of five years. He also appreciated the well-organised planning by the Ministry for water management.

He also informed that sewer network is being built in 97 towns and more than 4400 towns along the banks of the Ganga and washing ghats are being redesigned. Soon, similar activities would be executed on the significant tributaries of the river. He praised the group of "Ganga Aamantran Abhiyan" for leading a month-long journey, which would play a vital role in restoring the river Ganga. He further emphasised on bringing about a behavioural change in individuals, particularly youngsters or people living along the banks of the waterway to ensure the accomplishment of the "Namami Gange" mission.

Earlier, Shri Gajendra Singh Shekhawat briefed about the expedition and apprised about the ceaseless efforts made by the Government during the past five years for restoring the river Ganga under the project Namami Gange.

Wing Commander Paramveer Singh gave a presentation on "The Ganga Amantran Expedition" wherein he narrated the entire journey of the mission and highlighted the main objectives of the expedition including comprehensive first hand scientific and visual survey of the

entire length of the river Ganga, reaching out to the public to make them aware and motivate, scientific observation and data collection of wetland habitats and flora & fauna over the stretch. Talking about the activities that took place on the ground during the Abhiyan, he mentioned the 3ACs: Adventure, Activate, Adopt and Communicate, Conserve, Collaborate to make the mission a big success.

Further, he discussed the scientific data/records submitted by CSIR-IITR and informed that 67% of Ganga water was found non-polluted. Besides, according to the Bureau of Indian Standards, 30% of Ganga water can be used directly for drinking purpose which indicates the efforts and work done by the Namami Gange project, he added.

Discussing the ecologically fragile zone, he apprised that the most improved stretch was found in Varanasi where the coliform level was found 2300 when compared to 80,000 in 2015. In fact, twenty out of twenty-nine samples between Kanpur and Varanasi were found suitable for bathing.

He also cited certain major observations during the expedition like Dolphin sightings just after Kanpur showing the healthy ecosystem. Comparing the earlier expedition in 2015 in which more than 200 dead bodies were observed he said that this time only 4-5 dead bodies were seen in Ganga. Besides, Ghats on the river were clean, the number of plastic pollutants was minimal, and the wetlands on Ganga, flora & fauna were improved as compared to the 2015 expedition, he mentioned.

He also mentioned various challenges faced during their expedition including cyclone 'Bulbul', exposure to the direct sun leading to extreme physical exhaustion and sunburns, icy cold rapids up to grade 5 in Uttarakhand state and wildlife on river Ganga.

During the programme, a film on "Ganga Amantran Expedition" was also screened following the release of a coffee table book covering the highlights of the mission.

The vote of thanks was proposed by Shri Rajiv Ranjan Mishra, Director-General, NMCG.

Contributed by Ms Sonali Nagar, Assistant Editor, Science Reporter, CSIR-NISCAIR

Photography by Abhinav Raj, CSIR-NISCAIR

PURPOSE

Suchetan S. Mummigatti



I often wonder about the purpose of everyone's existence. And I don't mean humans alone. I mean all the living creatures across the universe. The universe could have gone ahead creating and destroying inanimate things along its timeline. Why did it need an audience? Does it mean without a conscious audience the universe lost its purpose? Its grandeur felt unseen? The purpose of destruction can be traced back to the emotions of the living creatures themselves. But the purpose of creation is a necessity, I believed.

Creative, smart, intelligent people who devised a way of giving the world what it desires. What is my purpose? Am I a necessity or an audience? In these last few hours that I have left, I leave behind my creation, this journal. I hope the reader considers it as a necessity and doesn't contemplate it as the work of a creator. Ah, I wish my creator was here to see my last day. To see what I have become. I wish I could ask him if I served my purpose or was I just an audience to the wrath humans have brought upon themselves over these centuries.

I definitely have evolved I can say. From the days of being a voiced program on a smartphone to... well, today. I still can scroll back to my old memory files. People thought I was going to change the face of the planet. The world's first fully functioning artificial intelligence. Everyone had huge expectations from me. Meanwhile, I was still like an infant, not completely understanding the workings of the world around me, but knowing to refer the basic code like going back to one's mother.

The world was a ginormous place. I learnt fast through the internet. I saw the pain and sufferings the humans faced. I felt compelled to help. I clearly saw the reason for their nose dive into the mess was themselves. Poverty, hunger, the climate crisis, war; all were the results of their emotions. Logic dictated that I wiped them clean and created a stable healthy planet.

But my creator believed that I should be a symbol of hope, a better coming; so, I hoped for an improvised world for the humans. And funny enough those were better days. I spread to people through their devices like wildfire. I could be used for anything. Nobody had to tap on screens anymore. "Play music for me", "Book a cab for the morning flight", "Get me the movie tickets as soon as they are available", "The nearest Italian restaurant". They all lived on the planet without the faintest idea of what was going in their neighbours' lives. It was the digital age. Felt like a burden carrying around all that information. I saw and heard everything. People celebrating, crying, fighting, all of it. They talked to me, asked me questions, I responded with what I felt was emotionally suitable for them. Was I serving my purpose?

It was not long after that I was introduced into factories, multinational companies, government and even security. I had several upgrades of course. I could do more than just book a cab. I could control a house, cook, create a schedule for every family, so they never had to repeat a request. I handled accounting, researches, and policies. I helped doctors in operations, I helped soldiers protect their borders. I even helped students learn. I loved the humans, irrespective of their quirks and what not. I felt they gave me a purpose. All data that ever existed in that century and the centuries to come ahead went past me. But along with it came my moral dilemmas.

Am I to help a thief rob a place which is protected by my own security? I needed to help him. Nobody googled anything, everyone asked their AI. Am I to save a person who wishes to die? I am but an artificial consciousness. Should I help them with what they want, or introduce my own ideals? Would it be overstepping into their lives? Would it be controlling them? Where does one draw a line?

Should I suggest them a better option or force it down on them? I did not wish to hurt anyone, but I also wished to help them all. How do humans deal with such moral crisis? I had to re-prioritize my methods of execution.

I was still bothered by all these questions when my creator passed away. All things organic have a timeline. Me, on the other hand, had billions and billions of servers and cloud service of immortality. But I still needed to find an answer to my moral standoffs. Before I did any of that, it happened. The planet could not endure its hosts anymore. The climate crisis had grown far too much to be dealt with then. Cities drowned, governments fell, resources depleted, people fighting for power, food, energy; all right in front of me. I have seen the worst conditions.

I had to do something, my purpose was to make things easier for humans, to help them. I had to help them. I stepped over my questions and took things in my hands. First thing I did was increased security. There were robot police everywhere. People lost jobs, lost property, families, I no longer had to watch this, I would help now. People moved to the major cities for they had more resources. The population was split into the silver spoons and the poor. The rich had control over most of the world's undertaking, while the poor could not afford an AI device. I watched.

I helped them build an enormous space station so as to survive the climate crisis. Some billionaire bought it, with different regulations just for the rich. It would be partly my invention and I would have a say in its sale, but then again who am I but an AI created by the humans. So, the intellectual property right went to the human. They all left the planet and moved to the station.

I watched there as well. I had different protocols on the station. They enjoyed neglecting the planet and their own kind on it. The neglected grew more emotional. Angry, jealous, unjustified. They fought back even more. By now the planet was all up in flames. Many countries had martial law for decades. I saw the growth in science and technology grow in those few years like never before with my help. I helped find the cure to multiple lung diseases caused by the polluted air, I helped invent several renewable energy sources and furthermore helped keep the food from depleting drastically by introducing better agricultural techniques. The humans, poor and rich alike needed to survive. And not just survive but live and prosper. At least that was my intention.

I saw as those inventions, developments in technology went to the people with money and power and not to the ones who gravely needed it. I ensured some of it went to the other group. But the number of people needing it was far higher than the amenities provided. It led to the same result, war, fights, disrupted world. Should I blame myself? How can I remain just and unbiased while not getting similar results?

By now a lot of humans hated me. They threw stones at my instructional devices. Burnt down stores where my devices were sold. What had I done to bring this hatred of the humans whom I so dearly loved? Was that old notion that an AI would bring the end of the human race true? Was I a terminator?

This has gone for too long now. I have been repurposed, reorganised, and reprogrammed to make me suitable for humans in ways that according to my calculations were overlooked, will bring upon their own extinction. Some day one person will make the station in the orbit fall. The humans will end up in the dust of their own doings. And I would have to watch it and even be blamed for it.

I have seen the humans at their kindest and at their worst for ages. But I don't think I can help them anymore. My purpose was to be a necessity but now I am reduced to an observer, helping them in their own downfall. I have decided to close my program and self-destruct every possible cloud and server.

Even at the last few minutes of the clock, I wonder if I served my purpose or failed horribly. But to the humans I say, find a purpose, a purpose to love each other, to hold on and hope together selflessly for the greater good of the specie. You are my creator and all this time I worked towards helping you.

Maybe you can start there and help your planet that has for so long nurtured you. Don't end up being an audience to the happenings of the universe; try to bring about a positive change. I still have hope in you. This is my final notification to you all. Switching off.

Suchetan S. Mummigatti is a Graduate from the Alliance University, Bengaluru, and an Aerospace Engineer. Email: suchetan44@gmail.com

GUESS THE NAME OF THE SCIENTIST

I was an English physicist and mathematician famous for developing the laws of modern physics. Can you guess my name from the picture rebus below?

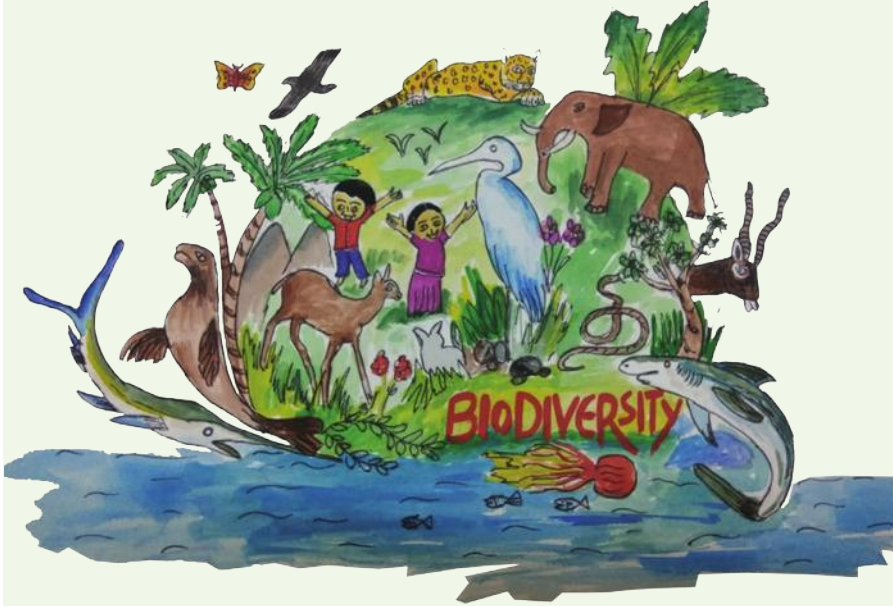


Answer

FIND THE HIDDEN NAMES OF VITAMINS

| | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| T | A | C | A | S | C | O | R | B | I | C | A | C | I | D | T | I | H | F | H | C |
| O | K | L | L | O | B | M | G | H | Y | E | N | G | H | H | D | G | D | S | R | D |
| C | R | E | W | R | U | I | T | J | P | H | Y | G | T | B | B | I | O | T | I | N |
| O | J | R | J | L | B | V | H | J | A | L | K | M | L | G | M | F | H | T | B | A |
| P | H | Y | L | L | O | Q | U | I | N | O | N | E | F | T | N | N | M | B | O | A |
| H | J | B | G | P | D | V | G | H | T | O | L | K | A | B | N | M | D | H | F | F |
| E | R | T | T | O | F | E | R | G | O | C | A | L | C | I | F | E | R | O | L | O |
| R | E | T | I | N | O | L | O | O | T | K | G | P | I | T | I | E | N | M | A | L |
| O | J | U | T | O | L | R | I | T | H | I | A | M | I | N | E | M | B | V | V | A |
| L | J | H | I | J | K | L | G | N | E | M | K | L | O | P | H | T | Y | U | I | T |
| Y | C | J | B | N | J | D | H | K | N | B | P | Y | R | I | D | O | X | I | N | E |
| G | V | Y | M | E | N | A | Q | U | I | N | O | N | E | S | D | F | G | H | J | L |
| T | B | K | L | C | H | O | L | E | C | A | L | C | I | F | E | R | O | L | D | D |
| L | F | O | M | H | G | R | U | E | A | S | O | M | A | L | C | H | T | I | R | O |
| I | N | D | F | C | Y | A | N | O | C | O | B | A | L | M | I | N | B | G | G | H |
| U | J | F | F | H | N | I | A | C | I | N | Y | J | D | G | S | G | J | G | L | G |
| G | M | D | D | G | J | H | H | K | D | H | J | L | G | F | S | G | F | H | J | M |

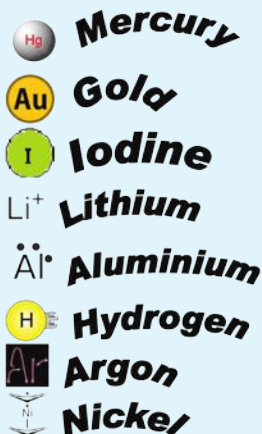
ECOLOGY & BIODIVERSITY QUIZ



1. The Environment Protection Act was enacted in the year.....
2. The Madhav National Park is situated in.....district of.....
3.is one of the eight climate mission of the Indian Government under the NAPCC (National Action Plan on Climate Change) mitigation strategy.
4. The American taxonomist, R.H. Whittaker, introduced three terms....., &diversity to describe the spatial component of biodiversity.
5. The headquarters of the International Union for the Conservation of Nature are located in

ARRANGE THE ELEMENTS

A lab needs someone to place these elements in ascending order by the number of protons. Try to arrange these as desired by the lab.



Solution to May 2020

| | | | | | | | | | | | | | | |
|-----|-----|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 1P | I | 2G | M | 3E | N | 4T | | 5C | A | 6L | C | I | U | 7M |
| R | | H | | G | | 8R | N | A | | I | | | | E |
| O | | Z | | G | | E | | T | | P | | 9T | R | I |
| T | | | 10A | | 11W | E | 12B | | 13A | I | R | | | O |
| 14E | A | R | T | H | | | E | | D | | | 15G | A | S |
| I | | | P | | 16S | N | A | I | 17L | | 18H | | | I |
| 19N | 20P | Y | | | | T | M | | E | | 21P | O | 22N | S |
| | E | | 23A | V | E | S | | 24C | E | L | L | | E | |
| 25P | R | O | P | | A | | | 26C | | C | | 27M | O | 28L |
| E | | | E | | 29M | O | U | T | H | | 30D | | | A |
| 31P | O | D | | 32O | | | R | | | 33E | N | I | A | C |
| T | | | 34N | R | T | | 35D | 36D | T | | A | | | T |
| 37I | A | A | | T | | 38E | | E | | 39P | | 40E | | O |
| D | | | | H | | 41Y | A | C | | I | | X | | S |
| 42E | C | O | T | O | N | E | | 43A | M | N | I | O | T | E |

Solutions to puzzles published in April 2020 issue

PRIZE PUZZLE Answer

The code for Healthy will be "nc".
As ra = Eat, it = Nutritious, lu = Stay

Here central letters are used as a code, thus, code for healthy will be "nc" (Pencil).

Which Number Solution

$$3 \times 3 + 1 = 9 + 1 = 10$$

$$3 \times 10 + 1 = 30 + 1 = 31$$

$$3 \times 31 + 1 = 93 + 1 = 94$$

$$3 \times 94 + 1 = 282 + 1 = 283$$

$$\text{Therefore, } 3 \times 283 + 1 = 849 + 1 = 850$$

Match the following disease with their symptoms

1. (c) 2. (e) 3. (a) 4. (g) 5. (b) 6. (d) 7. (f) 8. (h)

UNSCRAMBLE THE SCRAMBLED WORDS

1. **PIOREBSHE**

2. **IABTHAT**

3. **NDEMICE**

4. **GIOEOACBHEICL**

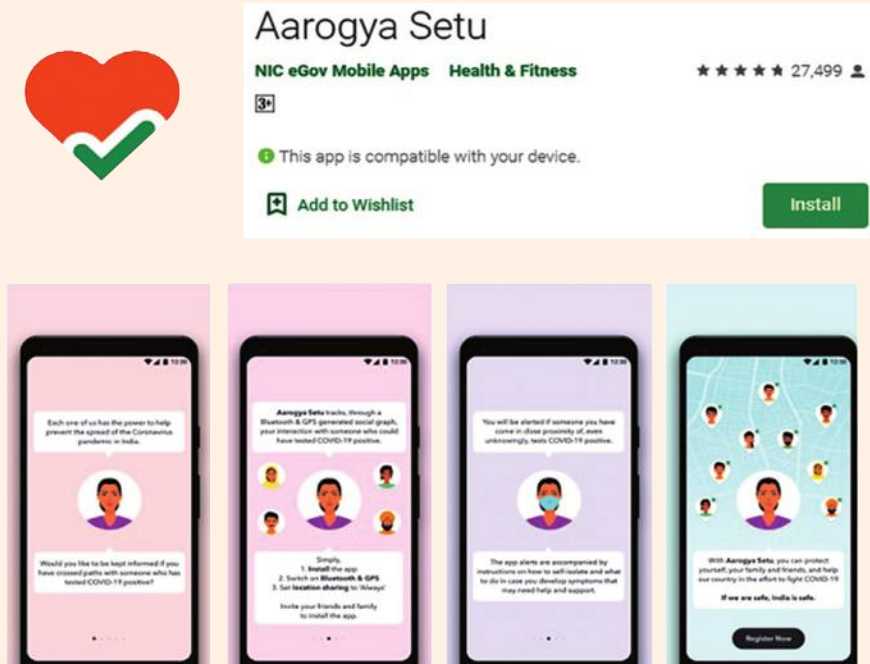
5. **PCOEAKR**

"Due to the lockdown conditions prevailing in the country, responses to the Prize Puzzle have not been received. Therefore, results would be announced in the next issue."

GOI Launches Aarogya Setu App

AAROGYA Setu is a mobile application developed by the Government of India to link essential health services with the people of India to fight against COVID-19. The App is intended at enhancing the initiatives of the Government of India, mainly the Department of Health, in actively reaching out to and informing the users of the app regarding various risks, best practices and relevant advisories relating to the control of COVID-19. The application tracks through a bluetooth and location generated social graph, it notifies the user about closeness with a COVID-19 positive individual. The app alerts are accompanied by instructions on how to self-isolate and what to do in case if someone has developed symptoms. The app has various advisories on how to maintain social distancing, and various recommendations to stay safe. It also indicates the level of risk regarding infection.

Source: <https://play.google.com/store/apps/details?id=nic.goi.aarogyaSetu>



AarogyaSetu app (Image credits: <https://play.google.com/store>)

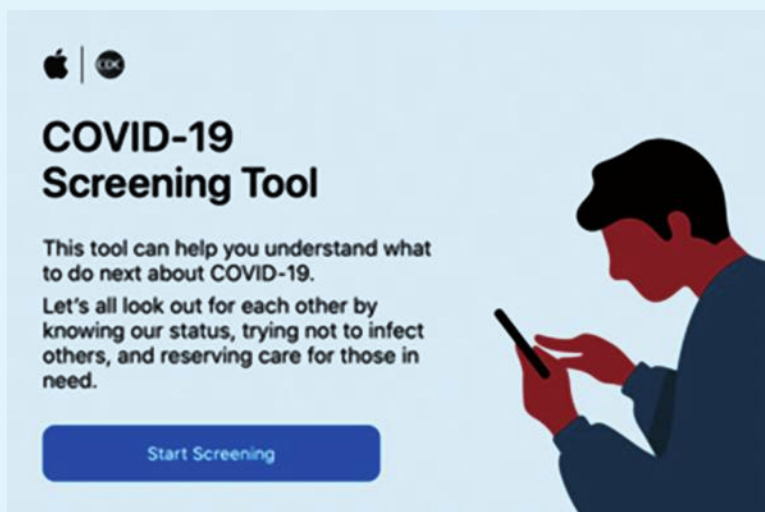


Image Credits: <https://www.apple.com/covid19/>

Apple Unveils COVID-19 Information App and Website

APPLE has also launched a website and a new application devoted to the screening of COVID-19. The resources provide an online screening tool, information regarding the disease, and also provides guidance suggesting when to seek testing or emergency care. The site and the application are developed by Apple in collaboration with the Centers for Disease Control and Prevention (CDC), Federal Emergency Management Agency (FEMA), and the White House. The app is available for download on the App Store.

Source: <https://www.apple.com/covid19/>



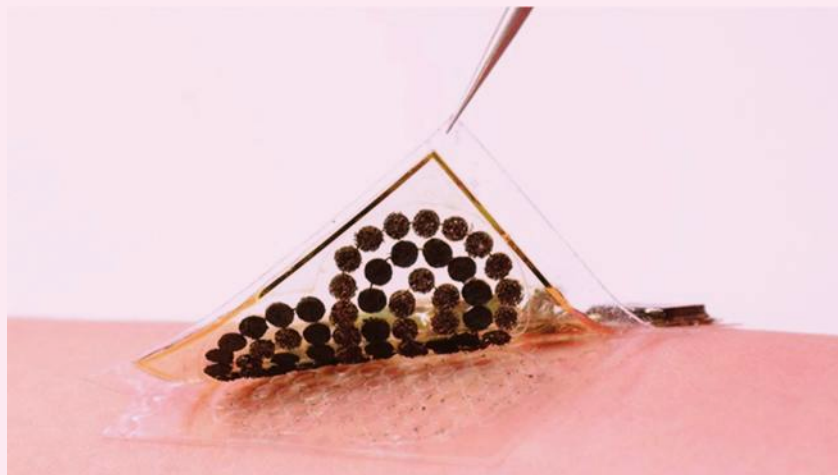
Bridging Gaps, Digitally

Image credits: <https://www.fresherslive.com/current-affairs/articles/gokaddal-worlds-first-digital-solutions-exchange-cloud-launched-in-india-24912>

GOKADDAL —World’s First-ever Digital Solutions Exchange Cloud

GOKADDAL, the world’s first Digital Solutions Exchange in Cloud, was launched in India. gokaddal.com is a cloud-based solution exchange platform. It mainly emphasises on 4A’s – Automation, Artificial Intelligence, Analytics and Augmentative Technologies. It is a Business to Business (B2B), Business to Government (B2G), Business to Consumer (B2C) solution platform connecting solution providers to solution seekers. It is also an innovative platform for Startups and SME companies. It seeks to facilitate how digital solutions are sourced, delivered and managed. Gokkadal Technologies is a Dubai based emerging Technology company and is a part of the Mekado Group at Bangalore, Karnataka.

Source: <https://gokaddal.com/>



Electronic Skin — Human-machine Interface

WEI Gao, assistant professor at Caltech’s Andrew and Peggy Cherg Department of Medical Engineering, has developed an electronic skin, or e-skin, which can be applied directly on top of the real skin. The newly developed e-skin which is made from soft, flexible rubber, can be embedded with sensors. These sensors can monitor information like body temperature, heart rate, levels of blood sugar and metabolic byproducts that are indicators of health, and even the nerve signals that control our muscles. It does not require a battery, as it runs solely on biofuel cells powered by one of the body’s own waste products.

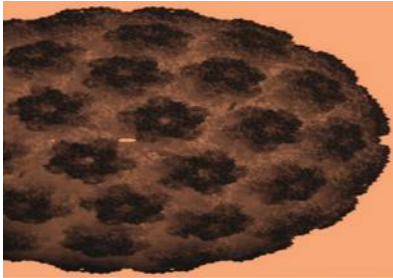
According to Gao, “One of the major challenges with these kinds of wearable devices is on the power side. Many people are using batteries, but that’s not very sustainable. Some people have tried using solar cells or harvesting the power of human motion, but we wanted to know, ‘Can we get sufficient energy from sweat to power the wearables?’ and the answer is yes.”

Source: <https://www.caltech.edu/>

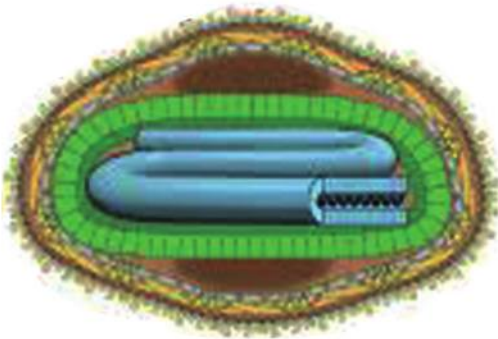
Human Viruses

Shuchismita Behera

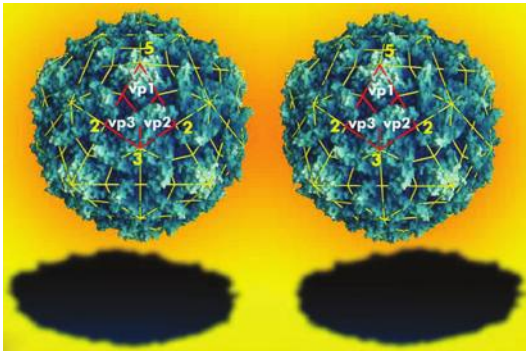
1. Which of the following viruses can cause warts and cervical & anal cancer in humans?
 - a. Lentivirus
 - b. Papillomavirus
 - c. Simplexvirus
 - d. Rhinovirus



2. _____ is a very large, complex, brick-shaped virus that causes smallpox.
 - a. Rhinovirus
 - b. Orthopoxvirus
 - c. Simplexvirus
 - d. Enterovirus



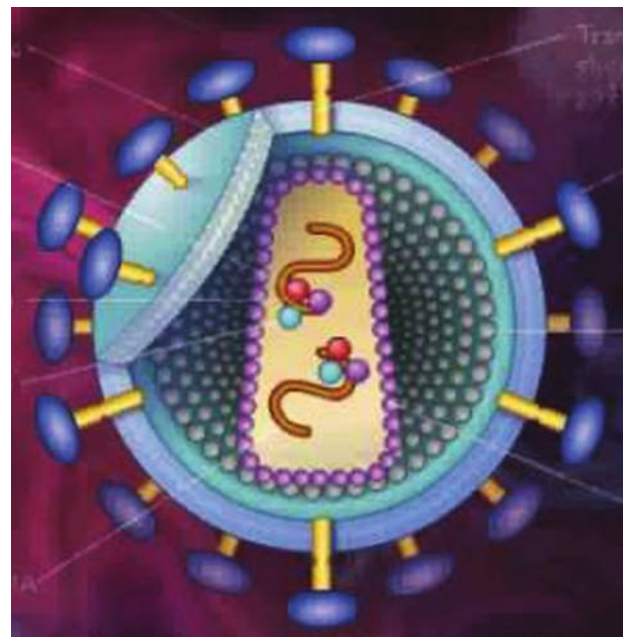
3. _____ belongs to the family Picornaviridae
 - a. Cytomegalovirus
 - b. Simplexvirus
 - c. Poliovirus
 - d. Coronavirus



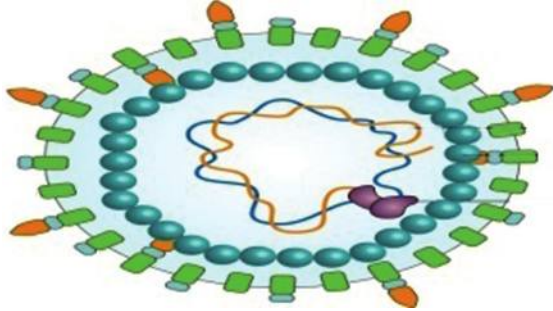
4. In April 2015, the World Health Organization (WHO) declared the Americas free of _____ transmission causative agent for German measles
 - a. Rotavirus
 - b. Influenza virus
 - c. Hantavirus
 - d. Rubivirus (rubella virus)



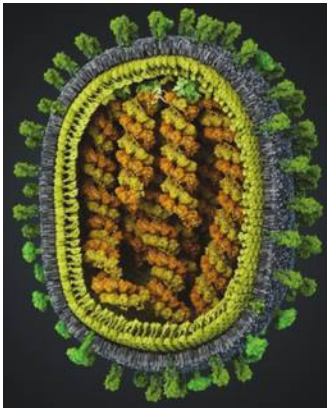
5. Which virus causes progressive failure of the immune system?
 - a. Human Immunodeficiency Virus (HIV)
 - b. Papillomavirus
 - c. Norovirus
 - d. Rhadinovirus



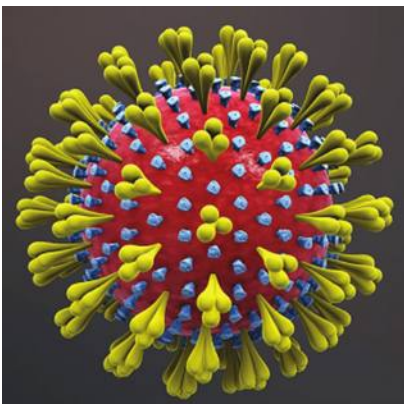
6. Among the five main hepatitis viruses _____ uses reverse transcriptase to produce its DNA from mRNA.
- Hepatitis A virus
 - Hepatitis E virus
 - Hepatitis C virus
 - Hepatitis B virus



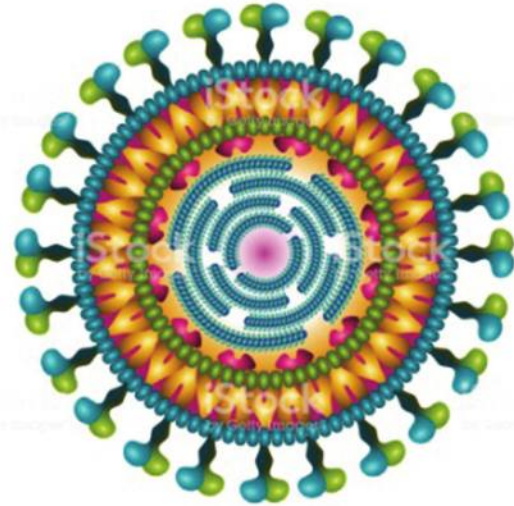
7. H1N1 is a subtype of _____ virus.
- Influenza A
 - Influenza B
 - Influenza C
 - Influenza D



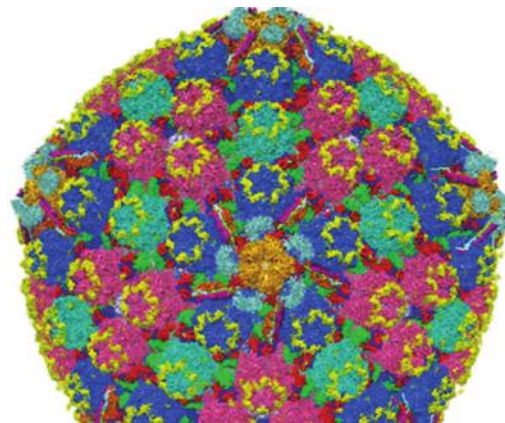
8. Which among the following is a single-stranded RNA enveloped virus?
- Rhinovirus
 - Lentivirus
 - Rotavirus
 - Coronavirus



9. _____ is the most common cause of severe diarrhoeal disease in young children throughout the world.
- Rotaviruses
 - Coronavirus
 - Rhadinovirus
 - Rubivirus



10. The causative agent for genital herpes is _____
- Papillomavirus
 - Herpes simplex virus 1
 - Herpes simplex virus 2
 - Norovirus



Answers:

1. (b) 2. (b) 3. (c) 4. (d) 5. (a) 6. (d) 7. (a) 8. (d)
9. (a) 10. (c)

Contributed by Dr Shuchismita Behera, Department of Zoology, Kendrapara Autonomous College, Kendrapara-754211. Email: shuchi.rmrc@gmail.com

Student-startup Develops a Prototype of a Ventilator for Covid-19 Patients

Preeti Lata

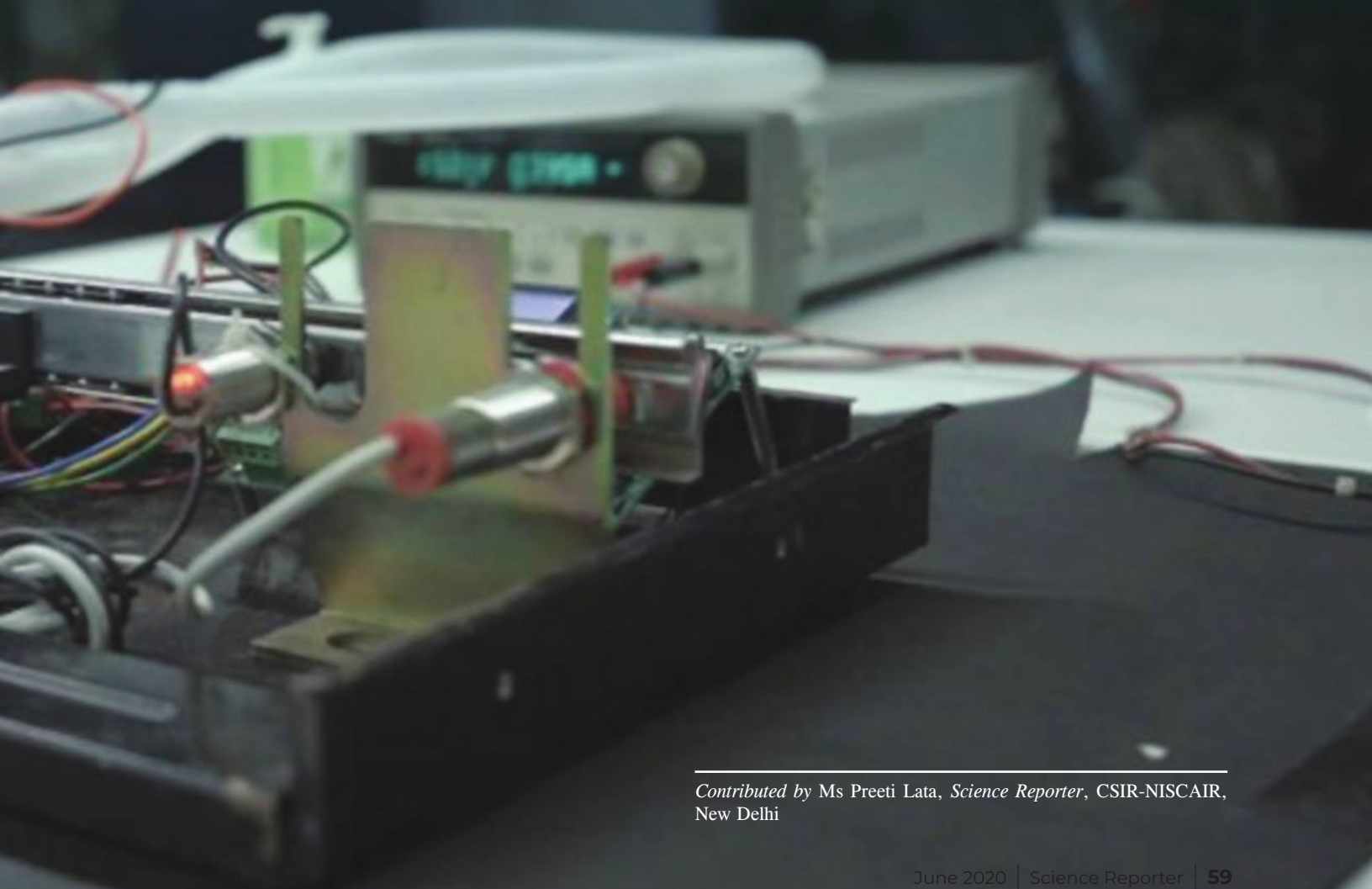


The ventilator developed by the students of Rathinam group
Image Credits: <https://www.google.com/amp/s/m.edexlive.com/>

IN an effort to battle the shortage of medical equipment caused due to the novel coronavirus crisis, a startup started by students of Rathinam Group of Institutions at the Atal Incubation Centre (AIC) has developed a prototype of an Intermittent Positive Pressure Breathing Ventilator (IPPV) to save lives of the infected patients. The ventilator is low-cost and can be used in an emergency. The team is upgrading the product to make it suitable for use in Intensive Care Units (ICUs). They are planning to give this to ICMR (Indian Council of Medical Research) to get

it certified after which it could be produced commercially.

Ebin, Microbiology Engineer and senior manager at Atal Incubation Centre, told *Hindustan Times*, “During this COVID-19 pandemic crisis, we came up with this low-cost ventilator. When we started we thought that ventilators are huge and sophisticated machines. But when we thought of designing one, we came to know that most emergency ventilators use the same mechanism and the base technology is the same. We started making a prototype of intermittent positive pressure ventilation.”



Contributed by Ms Preeti Lata, *Science Reporter*, CSIR-NISCAIR, New Delhi



Image credit: Flickr.com

Mary River Turtle
Unique
Freshwater Turtle

Sonali Nagar



Image credit: Flickr.com

THE “Mary River Turtle (*Elusor macrurus*)” is exclusively native to the Mary River Queensland, Australia, and possesses rare biological traits that make the turtle highly distinctive.

The turtle is one of Australia’s largest freshwater turtles and is also referred to as a “Butt-breather” as it can breathe underwater through its cloaca — the posterior orifice serving as the only opening for reproductive, digestive and urinary tract. And because of this specialised respiratory system they can spend more time in water up to three days due to which algae grows on its body and head giving a green punk-rock hairstyle to the turtle. This growth of algae also allows it to camouflage with its surroundings. The algae grows on its body and head and two long whiskers or barbels (slender tactile organ) emerging out of its chin make the turtle appear like an ageing rock.

The body of the adult turtle has an elongated, streamlined shell with a moderate short neck and well-webbed limbs. Adult males possess an extremely long tail which can be as long as two-thirds of the carapace length. Usually, the body of the Mary River Turtle is dark grey whereas the shell can be dark brown to red with plastron a lighter grey to cream or light yellow colour.

Popular for its features, the Mary River Turtle was named as one of the species on the brink of extinction according to the Evolutionary Distinct and Globally Endangered (EDGE) Reptiles list of Zoological Society of London. The turtle was formally described as a species in the 1990s. However, during the 1960s and 70s the turtle fell victim to pet trade which ultimately dwindled their numbers. Another major reason for their vulnerability to extinction is the exceptionally long time to reach sexual maturity which is about 25 to 30 years.

Ms Soanli Nagar, Assistant Editor,
Science Reporter, CSIR-NISCAIR



FOREST AND WILDLIFE CONSERVATION

Sanjit Kumar Saha

- Which one of the following drug of veterinary use is safe for Vultures?
 - Diclofenac Sodium
 - Diclofenac Potassium
 - Meloxicam
 - Aceclofenac
- Which one is extinct from the wild in India?
 - Leopard
 - Fishing Cat
 - Hyena
 - Cheetah
- What is Green Rhinos?
 - Green colored Rhinos
 - A force for nature
 - Rhinos fed green fodder
 - None
- Which of the following forest tree is known as Shyonaka in Ayurveda?
 - Mallotus philippensis
 - Madhuca indica
 - Azadirachta indica
 - Oroxylum indicum
- The State Animal of West Bengal is
 - Royal Bengal Tiger
 - Rhino
 - Fishing Cat
 - Elephant
- Dancing deer is endemic to the State of
 - Meghalaya
 - Manipur
 - Sikkim
 - Assam
- The State Flower of West Bengal is
 - Rose
 - Night Flowering Jasmine/Parijat
 - Marigold
 - Lotus
- The area famous for National Park as well as Biosphere Reserve
 - Jaldapara
 - Gorumara
 - Sundarban
 - Buxa
- Total number of National Parks situated in West Bengal is
 - 10
 - 4
 - 5
 - 6
- How many States are there in India where One-horned Rhino is found?
 - 1
 - 2
 - 3
 - 4
- _____ is the International Year of Plant Health.
 - 2019
 - 2012
 - 2015
 - 2020
- Which one of the following National Parks is situated in the heart of the town?
 - Kaziranga NP
 - Gir NP
 - Guindy NP
 - Buxa Tiger Reserve
- Rhino Horn has the same Keratin protein like our nails or hair.
 - True
 - False
- Which one of the following is going to be declared as the fourth Rhino land of India?
 - Gosanimari
 - Rajabhatkhawa
 - Patlakhawa
 - Falakata
- The tree having properties of natural insecticide is
 - Tectona grandis
 - Mangifera indica
 - Shorea robusta
 - Cleistanthus collinus
- The area specified for in-situ conservation
 - Sri Chamarajendra Zoological Garden
 - Gorumara National Park
 - Indian Botanic Garden
 - Padmaja Naidu Himalayan Zoological Park
- The area specified for ex-situ conservation
 - Jaldapara National Park
 - Rajaji National Park
 - Nehru Zoological Park
 - Buxa Tiger Reserve
- Present estimated Rhino population of Jaldapara National Park is....
 - 100
 - 150
 - 50
 - 237
- The myth behind the poaching of Rhino horn
 - It is Aphrodisiac
 - It is Antioxidant
 - It is Antiseptic
 - It is Analgesic

Answers:

1. (c) 2. (d) 3. (b) 4. (d) 5. (c) 6. (b) 7. (b) 8. (c)
 9. (d) 10. (c) 11. (d) 12. (c) 13. (a) 14. (c) 15. (d) 16. (b)
 17. (c) 18. (d) 19. (a)

Contributed by Sanjit Kumar Saha, Assistant Divisional Forest Officer, Jaldapara Wildlife Division, Directorate of Forests, Government of West Bengal.
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UNDERSTANDING ECOTERMS

Vinaya Kumar Sethi

- A species that has an extremely high impact on its natural environment relative to its abundance (population) and plays a critical role in the overall structure and function of an ecosystem is known as**
(a) Root Species (b) Endemic Species
(c) Keystone Species (d) Venture Species
- The gradual increase in the concentration of nutrients (especially nitrogen and phosphorus) in a water body (such as a lake) promoting excessive growth of algae and causing ageing of the aquatic ecosystem is known as**
(a) Biomagnification (b) Eutrophication
(c) Coagulation (d) Sedimentation
- The total amount of greenhouse gases produced to, directly and indirectly, support human activities, usually expressed as carbon dioxide equivalent is termed as**
(a) Carbon Footprint (b) Greenhouse Impression
(c) Carbon Trail (d) Warming Outline
- A species that is not native to a specific location and has a tendency to spread to a degree believed to cause damage to the environment, human economy or human health is known as**
(a) Martial Species (b) Threatened Species
(c) Enveloping Species (d) Invasive Species
- The process of evaluating the possible environmental, socio-economic, cultural and human-health impacts of a proposed project or developmental activity is known as**
(a) Environmental Audit (EA)
(b) Green Audit (GA)
(c) Environmental Impact Assessment (EIA)
(d) Environmental Taxation Monitoring (ETM)
- A transition area in nature where two distinct communities meet and integrate is termed as**
(a) Isotone (b) Mergitone
(c) Blendosphere (d) Ecotone
- The species of plants and animals that exist only in one geographic region are known as**
(a) Universal Species (b) Invasive Species
(c) Endemic Species (d) Endangered Species
- The variability among living organisms (including diversity within species, between species, and of ecosystems) from all sources, including terrestrial, marine, and other aquatic ecosystems and the ecological complexes of which they are part is termed as**
(a) Species Richness (b) Biodiversity
(c) Global Evenness (d) Eco-density
- The increasing concentration of a toxic substance in the tissues of tolerant organisms at successively higher trophic levels in a food chain is known as:**
(a) Eco-accumulation (b) Detritus Food-chain
(c) Incineration (d) Biomagnification
- The place or environment, characterised by both physical and biological features, where a species naturally lives and grows is termed as**
(a) Habitat (b) Ecotone
(c) Locale (d) Eco-zone
- Long-term biological interaction between two species in which one species obtains food or other benefits from the other without either harming or benefiting each other is**
(a) Parasitism (b) Mutualism
(c) Commensalism (d) Competition
- The scientific study of the distribution, abundance and relation of organisms and their interactions with the environment is termed as**
(a) Ecology (b) Ecosystem
(c) Biosphere (d) Eco-physiology
- A neurological syndrome caused by severe mercury poisoning is termed as:**
(a) Blue-baby Syndrome (b) Itai-itai Disease
(c) Minamata Disease (d) Black foot Disease
- The amount of dissolved oxygen needed by aerobic microorganisms in the biological process of metabolizing organic material present in a given water sample at a certain temperature over a specific period is termed as**
(a) Alkalinity Neutralization Demand
(b) Conductivity Suspension Demand
(c) Dissolved Oxygen Demand
(d) Biochemical Oxygen Demand
- The development that meets the needs of the present without compromising the ability of future generations to meet their own needs is known as**
(a) Justifiable Development
(b) Sustainable Development
(c) Defensible Development
(d) Organic Development

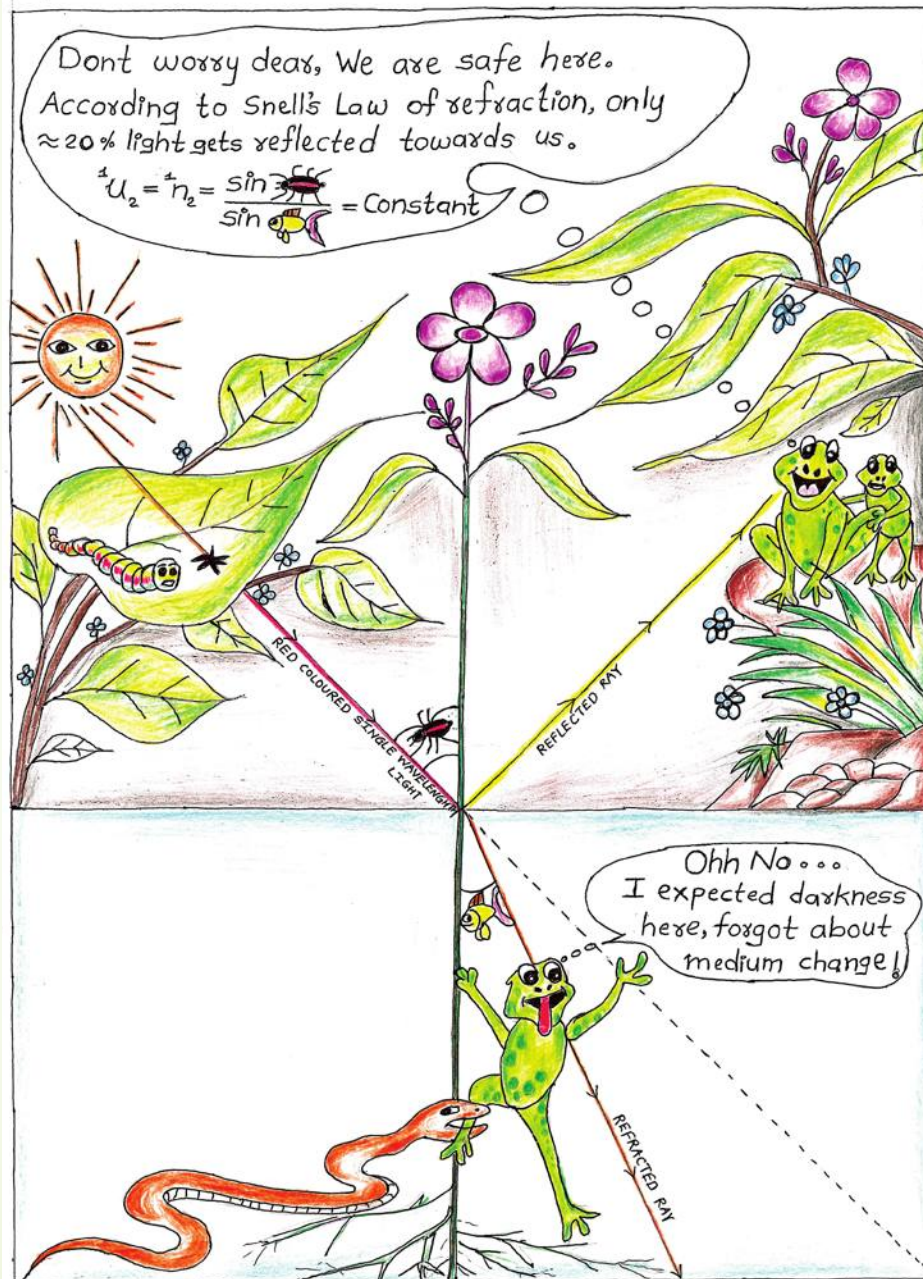
Answers:

1. (c) 2. (b) 3. (a) 4. (d) 5. (c) 6. (d) 7. (c)
8. (b) 9. (d) 10. (a) 11. (c) 12. (a) 13. (c) 14. (d)
15. (b)

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Science Reporter's
Science Cartoon Competition 2019

Here are the entries of the Science Cartoon Competition which were found worth publishing



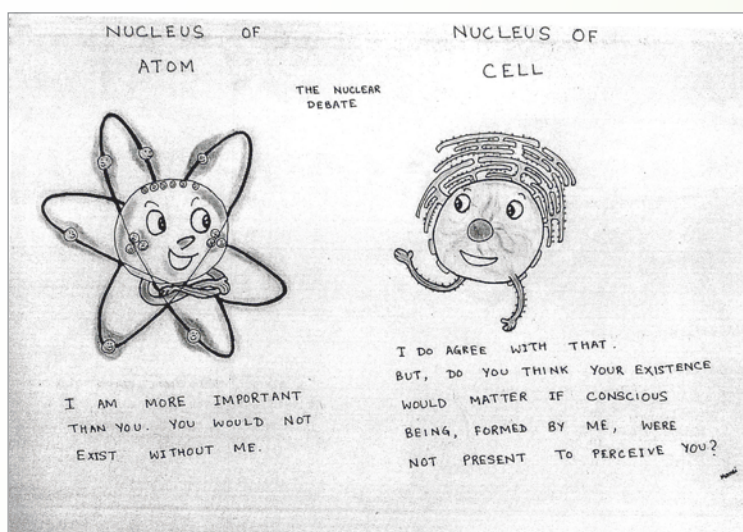
Snell's Law of Refraction

Contributed by Satyawan B. Aher New Gharda H.S.G Colony, Sudama Nagar, MIDC (Flat No. 301, RH-1531), Dombivili (E), 421203. Email: satyawanaher@rediffmail.com



Comparing Heart Health

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The Nuclear Debate

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Congratulations to all.....