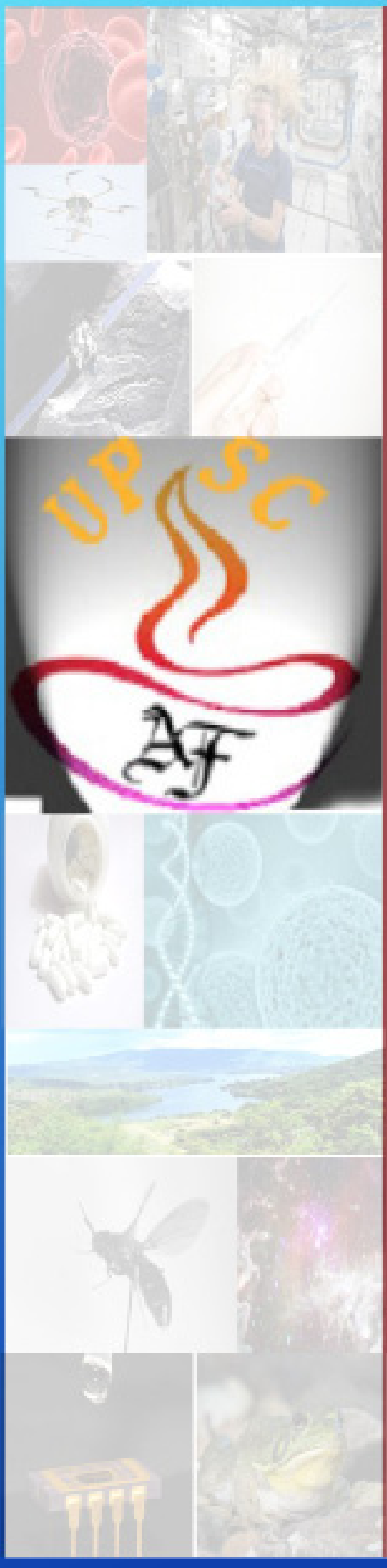

News for Oct-Dec 2017

SCIENCE AND TECH.

THE CRUX OF THE HINDU

Vol. 12

Important News in the field of

Space
Atomic Energy
Environment and Ecology
Health and Medicine
Bio-Technology
Computer and IT
Defence
Agriculture
Miscellaneous

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Science and Tech.
The Crux of The Hindu

Vol. 12

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Aspirant Forum is a Community for the UPSC Civil Services (IAS) Aspirants, to discuss and debate the various things related to the exam. We welcome an active participation from the fellow members to enrich the knowledge of all.

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About the 'CRUX'

After the success of our monthly magazine The Crux of The Hindu and PIB, we are introducing a new and convenient product, to help the aspirants for various public services examinations. Today, the knowledge of the Current Affairs (Science and Technology) constitutes an indispensable tool for all the recruitment examinations. However, as per the examinations are concerned, it is quite tedious task to memorise each and every news. Moreover, every news as given in magazines and newspapers may or may not be relevant from exam perspective which forces the candidates to spend a quality time in extracting useful matter and framing notes. This problem of aspirants strikes our minds and made us to think for a sure shot solution as a result of which our experts have come out with the unique magazine of Science and Technology, Crux of Science and Technology. This trimonthly convenient product is going to save our aspirants' time. The whole concept of the CRUX is to provide you with a summary of the important news and current affairs, from an exam point of view. By reading the CRUX, you will be able to save your precious time and effort, as you get all the relevant matter in a summarized and convenient form. The Crux is particularly helpful for the Civil Services, Banking, SSC and other exams that have a current affairs section. The material is being provided in such a manner that it is helpful for both- objective and descriptive sections. Our aim is to help the candidates in their effort to get through the examinations. Your efforts and dedication inspire us to keep going. It is our sincere effort to make your journey easier.

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SPACE

From noise to music: How the LIGO team heard the famous 'chirp'

With the 2017 Nobel Prize for physics going to the LIGO-VIRGO collaboration for having directly observed gravitational waves for the first time, black hole mergers have become a byword. The instrumentation to differentiate and detect this faint signal from the noise was a crucial contributions made by Nobel Laureate Rainer Weiss.

The first gravitational waves that were detected were small fluctuations of spacetime caused by a violent merging of two black holes about 1.3 billion light years away. We know that light bends due to a change in refractive index of the air near hot objects like a heated asphalt road. Light also bends when spacetime curves due to the presence of massive gravitational fields. When a gravitational wave is incident on the detector, the laser beam behaves in a similar manner. One main difference is the magnitude. The difference between bending of light in cool air and hot air is about 1%, whereas the bending caused by a gravitational wave is about one billion times smaller than the thickness of a human hair.

Sensing the minute

"That's pretty small. How can we turn something like this into a signal that's measurable to us?" asks Rana Adhikari, Professor of Physics at Caltech, who has been involved in the construction and design of the detectors since 1997. He explains, "From my PhD advisor, Rai Weiss, I got the strong impression that it was embarrassing to not understand in exacting detail all the constituents of the noise in the experiment. Once we went down the road of making the detailed study of noise a science in itself, we realized that there are no limits to measurement. Everything that we wish to understand about the universe can be revealed by careful design of experimental apparatus."

The photodetectors are sensitive to the brightness of the incoming signal. When there is no signal, the two arms of the LIGO detector are arranged so that there is cancellation of contribution of light. There is still some small amount of light coming through. When there is a signal, this light shows a variation. "We measure how much light is seen when it is very dark [that is, there is no signal]. This is about the same as a small handheld laser pointer. On top of that brightness, we are trying to measure a variation in brightness level of about one part in one billion. This is manageable. This is just what can be done with the best electronics that we have today," he says.

Ground vibrations

The electronics converts photons into electrons. Like in the human ear, there is an electrical signal which has to be turned into sound. The detection is in the range of frequencies from about 20 Hz to 10 kHz. "The challenge is how to reduce the vibration from the ground at those frequencies," Prof Adhikari says.

"[The relevant] ground vibrations are about 1% of the diameter of the hydrogen atom, or one hundred million times larger than we can handle. We need this vibration to be reduced by a factor of one hundred million. We do this by using many, many springs" The arrangement is that of some six layers of heavy metal beds connected by strong springs. At every layer the vibrations of the ground are cut off by a significant factor.

LIGO's interferometers are a ten orders of magnitude improved as compared to the first interferometer made by Albert Michaelson in 1881, which was able to measure a displacement in nanometres.

Under the high degree of vacuum needed, stainless steel has the problem that the hydrogen separates out. So a special stainless steel called low-hydrogen stainless steel was needed. The steel tubes are also used to house the lasers and have to be very clean. These are being made at Institute for Plasma Research in Ahmedabad.

In all, the tubes measure 8 km in length and have a diameter of 1.2 m. "So it's quite a large empty space, and it's all one piece. No one had made such a large vacuum chamber earlier, so this is the largest empty space in the world," Prof. Adhikari smiles.

Workings of solar wind flows deciphered by PRL team

A group of researchers from Physical Research Laboratory (PRL), Ahmedabad, have, for the first time, figured out the conditions under which certain types of solar storms can flow towards the earth and affect its atmosphere. This is important because such storms contain charged particles travelling at very high speeds and these can affect the electronics present on satellites in orbit around the earth. The research was published in Geophysical Research Letters.

Solar storms are violent events on the sun which can temporarily distort the earth's magnetosphere – the region around the earth which is influenced by its magnetic field. These temporary disturbances, called geomagnetic storms, can generate shock waves in the interplanetary medium that can accelerate charged particles to very

high energies and which, in turn, can harm the satellites placed by humans in space. Such solar storms have two causes: Coronal Mass Ejections (CME) and Corotating Interaction Regions (CIR).

CME and CIR

CMEs are huge explosions of charged particles extending beyond the sun's corona or outer layer and can be visibly observed. CIRs are much more complicated and difficult to observe. "CMEs can be detected by a coronagraph when they are ejected from the Sun… CIRs are generated in the interplanetary medium and there are no visual signatures for CIRs. Hence, in order to detect [them], solar wind parameters need to be characterised critically," says Diptiranjan Rout, the first author of the paper and a post-doctoral fellow at PRL.

Charged particles are being spewed continually out of the sun's corona, forming the solar wind. Some parts of these winds move faster than others. Since they contain charged particles in a plasma state, these different regions physically interact with each other to form wavelike disturbances called CIRs that emanate from the sun and spiral outwards.

They are called "corotating" interaction regions as they rotate along with the sun, attached to it at one end.

The sun goes through cyclic variations with a period of eleven years during which sunspot activity increases to a maximum and then decreases. The researchers studied 43 geomagnetic storms linked to CIRs during the years 2006-2010 which corresponded to the minimum of solar activity in that particular solar cycle.

"It took rigorous data analyses for almost a year to identify the final pattern," says Mr. Rout.

L1 point

There is an imaginary point on the line joining the sun and earth known as the L1 point or the Lagrange 1 point. A special feature of this point is that a particle placed there will feel no gravitational pull due to either the sun or the earth as the two forces cancel each other. "[Only those] CIRs that come at an angle of 6 degrees or less at the first Lagrangian point of the Sun-Earth system (L1 point) affect the earth's outer plasma environment," says D. Chakrabarty, Associate Professor at PRL and Mr Rout's thesis advisor. Those CIRs that are incident at angles more than 6 degrees at the L1 point will not reach the earth.

This is the first time that such an understanding has been arrived at.

The group plans to further focus on the causes for the events when solar wind flow angle deviates from 6 degree for a considerable duration of time.

JNCASR: Super-packed organic transistors for flexible devices

A nano-array with one billion transistors in 1 sq. cm area has been developed by researchers from Jawaharlal Nehru Centre for Advanced Scientific Research (JNCASR), Bengaluru. Though tiny, these transistors provide higher output current in comparison with conventional organic field transistors used in organic light emitting diodes.

As the new device is not rigid and uses organic semiconductor inks, it can also be used in flexible displays and sensor technology.

They developed the new vertical organic transistors called Organic Nano-Triode Array. "At 100 nm, each transistor in the circuit measures 500 times thinner than the human hair and it is half a micron in height. We made it in the lab using a simple templating technique," explains K. Swathi from the Department of Molecular Electronics at JNCASR and first author of the paper published inNano Letters. "In the regular organic field effect transistor, there will be 5-10 transistors in 1 sq. cm area. But in our case, about one billion transistors can be packed in the same area."

The cost per transistor is drastically scaled down with this procedure. "Curved, flexible and foldable device technology is increasing every day and these new electronic products require smarter, slimmer circuits which can provide high throughput at low cost. Transistor technology is now shifting to 3D circuits which can pack more components in a smaller area. With this in mind, we developed the new nano-array which can house higher density of transistors," says K.S. Narayan from the Department of Molecular Electronics, JNCASR.

The researchers carried out two types of measurements to study the capacity of the nano-array. The first one is the typical transistor measurement of the entire array. The second set of measurements involved studying each pore of the array and demonstrating its transistor action. They concluded that the new transistor can be turned-ON to the high conducting state with a low voltage of less than 3 V.

The molecular electronics laboratory at JNCASR is building a portfolio of different devices in the area of organic electronics. Further design and development is needed to fully address these vertical transistors as functional blocks to build circuits.

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SCIENCE-PLANET-SNOW

The Hubble Space Telescope has spotted a blistering-hot giant exoplanet, Kepler 13Ab, where the atmosphere "snows" titanium dioxide - the active ingredient in sun-screen. The finding provides insight into the complexity of weather on exoplanets, and may be useful for gauging habitability.

Chandrayaan-2: Isro begins flight integration activity for next lunar mission

The Isro has started flight integration activity for its next lunar mission Chandrayaan-2 and scientists are currently carrying out tests for the lander and the rover that will explore the moon. Officials said the spacecraft launch, on board GSLV-Mk II, is planned for March and many new technologies have been developed indigenously to achieve the mission requirements.

Chandrayaan-2, India's second mission to the moon, is an advanced version of the previous Chandrayaan-1 mission nine years ago. This spacecraft is a composite model consisting of orbiter, lander and rover. According to Isro, unlike Chandrayaan-1, wherein an impact probe crash-landed on the surface of the moon, Chandrayaan-2 will soft land its lander with the rover on the lunar surface to conduct the next level of scientific studies.

"Things are going on. The orbiter is getting ready. Flight integration activity is going on, and a series of tests are planned for lander and rover. They are all in progress and we are working towards the first quarter (of 2018) launch of Chandrayaan-2," Isro chairman A.S. Kiran Kumar told PTI.

Officials said rover flight systems test include "soil mixing exercise" and mobility test to evaluate the rover's wheel-soil interaction. According to them, the lander configuration has been finalised to meet soft and safe landing at the identified site, as also payload configuration and interfaces with the lander.

Indian Space Research Organisation (Isro) had also established a lunar terrain test facility for conducting lander leg drop tests. "It is a totally Indian mission; no other collaboration," Kumar said. "It (Chandrayaan-2) differs from the previous one (Chandrayaan-1) in the sense that in the last one, we had moon impact probe that descended on the moon in an uncontrolled manner, whereas this (Chandrayaan-2) will carry a lander, which will descend on the surface of the moon in a controlled manner," he said.

After the lander lands on the moon, the rover will come out and it will do some in-situ observations and we will be able to get these observations through radio contact, Kiran Kumar said.

Nasa discovers 1st interstellar space object racing through solar system

A small asteroid or comet that has been spotted racing through our solar system may have come from elsewhere in the galaxy, US space scientists say, possibly marking the first such interstellar visitor observed from Earth.

The mystery object, so far known only as A/2017 U1, was discovered earlier this month by a researcher using a sophisticated telescope system at the University of Hawaii that continually scans the universe for such phenomenon.

"We have been waiting for this day for decades," said Paul Chodas, manager of the Nasa's Center for Near Earth Object Studies at the Jet Propulsion Laboratory in Pasadena, California.

"It's long been theorized that such objects exist — asteroids or comets moving around between the stars and occasionally passing through our solar system — but this is the first such detection," Chodas said.

The mass, a quarter mile (400 meters) in diameter, quickly stood out for scientists because of its extreme orbit, coming from the direction of the constellation Lyra, almost directly above the elliptical plane where the planets and other asteroids orbit the sun.

It crossed under that plane just outside Mercury's orbit on 2 September before being slung by the sun's massive gravity into a sharp turn under our solar system. The closest the object came to Earth was about 15 million miles away on 14 October.

"It is going extremely fast and on such a trajectory that we can say with confidence that this object is on its way out of the solar system and not coming back," Nasa'sDavideFarnocchia said.

Astronomers were urgently tracking A/2017 U1 with telescopes as it makes its journey through our solar system, hoping to use that data to confirm the object's interstellar origins and learn what they can about its composition.

If the object is formally established as the first of its kind spotted from Earth, rules for naming it would have to be set out by the International Astronomical Union, Nasa scientists said. Reuters

Scientists detect gravitational waves, light from neutron star collision

This image obtained from the European Southern Observatory on 16 October 2017 is an artists impression showing two tiny but very dense neutron stars at the point at

which they merge and explode as a kilonova. Photo: AFP
Cambridge, Massachusetts: Scientists in the US and Europe have for the first time detected gravitational waves, the ripples in space and time predicted by Albert Einstein, at the same time as light from the same cosmic event, according to research published .

The waves, caused by the collision of two neutron stars some 130 million years ago, were first detected in August in the Laser Interferometer Gravitational-Wave Observatories, known as LIGO, in Washington state and Louisiana as well as at a third detector, named Virgo in Italy. Two seconds later, observatories on earth and in space detected a burst of light in the form of gamma rays from the same path of the southern sky, which analysis showed likely to be from the same source.

Less than two years have passed since scientists working at the Massachusetts Institute of Technology and the California Institute of Technology first detected gravitational waves coming off two black holes.

The gravitational waves had been predicted by Einstein in 1916, as an outgrowth of his groundbreaking general theory of relativity, which depicted gravity as a distortion of space and time triggered by the presence of matter.

Three US scientists who made that discovery were awarded the Nobel prize in Physics earlier this month.

The findings published help confirm Einstein's theory, said the researchers, whose work was published in Physical Review Letters.

"From informing detailed models of the inner workings of neutron stars and the emissions they produce, to more fundamental physics such as general relativity, this event is just so rich," said MIT senior research scientist David Shoemaker. "It is a gift that will keep on giving."

The LIGO instruments work in unison and use lasers to detect remarkably small vibrations from gravitational waves as they pass through the earth.

Previously, scientists could only study space by observing electromagnetic waves such as radio waves, visible light, infrared light, X-rays and gamma rays. Those waves encounter interference as they travel across the universe, but gravitational waves do not, meaning they offer a wealth of additional information.

The colliding neutron stars were smaller than the black holes that LIGO previously detected.

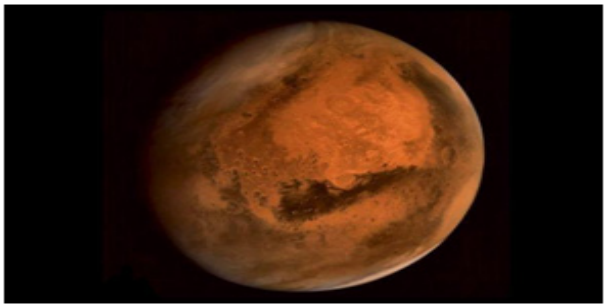
Black holes are so dense that not even photons of light can escape their gravity. Neutron stars are relatively small, about the size of a city, the compact remains of a larger star that died.

The National Science Foundation, an independent agency of the US government, provided about $1.1 billion in funding for the LIGO research over 40 years. Reuters

Water once flowed on 'cold and icy' ancient Mars: study

The study shows that it is plausible, even if Mars was generally frozen over, that peak daily temperatures in summer might sneak above freezing just enough to cause melting at the edges of glaciers. Photo: PTI

Washington: Water may have flowed on ancient Mars in peak summers, even though the red planet was generally frozen over, a study suggests. For scientists trying to understand what ancient Mars might have been like, the red planet sends some mixed signals.



While water-carved valleys and lake beds leave little doubt that water once flowed on the surface, climate models for early Mars suggest average temperatures around the globe stayed well below freezing. The study led by scientists at Brown University in the US offers a potential bridge between the "warm and wet" story told by Martian geology and the "cold and icy" past suggested by atmospheric models.

The study, published in the journal Icarus, shows that it is plausible, even if Mars was generally frozen over, that peak daily temperatures in summer might sneak above freezing just enough to cause melting at the edges of glaciers. That meltwater, produced in relatively

small amounts year after year, could have been enough to carve the features observed on the planet , the researchers conclude.

"We see this in the Antarctic Dry Valleys, where seasonal temperature variation is sufficient to form and sustain lakes even though mean annual temperature is well below freezing," said Ashley Palumbo, PhD student at Brown University. "We wanted to see if something similar might be possible for ancient Mars," said Palumbo.

The researchers started with a state-of-the-art climate model for Mars - one that assumes an ancient atmosphere composed largely of carbon dioxide as it is today. The model generally produces a cold and icy early Mars, partly because the Sun's energy output is thought to have been much weaker early in solar system history.

The researchers ran the model for a broad parameter space for variables that may have been important around four billion years ago when the iconic valley networks on the planet's southern highlands were formed. While scientists generally agree that the Martian atmosphere was thicker in the past, it is not clear just how thick it actually was.

Likewise, while most researchers agree that the atmosphere was mostly carbon dioxide, there may have been small amounts of other greenhouse gases present. Researchers ran the model with various plausible atmospheric thicknesses and extra amounts of greenhouse warming. The model produced scenarios in which ice covered the region near the location of the valley networks.

While the planet's mean annual temperature in those scenarios stayed well below freezing, the model produced peak summertime temperatures in the southern highlands that rose above freezing. The results offer a potential means of reconciling the geological evidence for flowing water on early Mars with the atmospheric evidence for a cold and icy planet, researchers said.

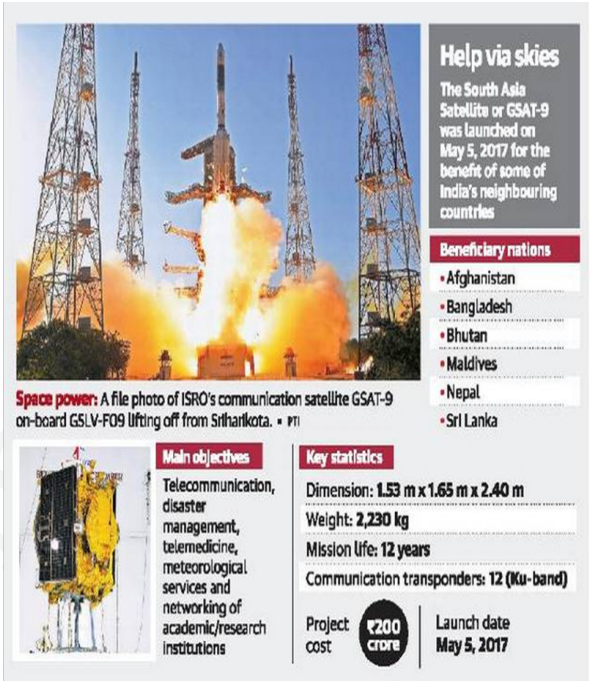
Study on hybrids

Both botanists emphasise that balsams have immense horticultural importance. Studies on hybrids of the plants have been undertaken in parts of the country to produce flowers that can sustain in different environmental conditions. Different hybrids can be created from wild balsam species, so it is important to know the actual number of balsam species in the wild, Mr. Borah said.

External ground delays holding up GSAT-9 benefits

We will support partner governments through Indian industry, says ISRO

Some five months after the South Asia Satellite or GSAT-9 was put up in space as New Delhi's gift to six neighbours, ground delays outside India seem to be holding up



its planned harvest.

The Indian Space Research Organisation, which owns and operates the roughly Rs. 200-crore communication spacecraft, says it has initiated the processes to set up ground stations for the partners to receive/send satellite communication. It has invited expressions of interest to find suitable Indian industry players who will set up the ground equipment.

While half of the satellite's 12 Ku-band transponders are reserved for the partners, the Indian part has been in use without a hitch.

A.S. Kiran Kumar, ISRO Chairman, told The Hindu , "It is a work in progress. We are now trying to get the partner governments to start using the services of the satellite. They must first set up the ground segment, depending on what they need." The satellite has a planned life of 12 years.

It would be a slow build-up as work must be coordinated with each of the six governments. "We are trying to push it as much as possible but it does not move at the pace that we would like. Eventually we will support them through Indian industry," said Mr. Kiran Kumar, who is also Secretary, Department of Space, that functions under the Prime Minister.

In India, which has a 50-year active space history, sat-

com-based activities can routinely begin in a couple of months after a communications satellite is launched. But for the smaller neighbours, space is a relatively new area. India's space programme is helping Afghanistan, Bangladesh, Bhutan, the Maldives, Nepal and Sri Lanka. Their satellite-based services are said to be small and some may be using commercial foreign satellites.

Speed in Bhutan

In the case of Bhutan, Mr. Kiran Kumar said there had been significant progress and many interactions, because of which "we are going ahead" faster than with the others.

To begin with, ISRO has enabled video transmission uplinked from India. Once the countries start using their part of satellite fully, he said it could open or spur activities for poor and unconnected areas — tele-education and tele-medicine or consultations with doctors, besides a SAARC library link of regionally relevant information.

India has offered each country one Ku-band transponder free of cost, along with services. The gesture is meant to spread the use of DTH television and VSATs to support Internet-based applications.

The South Asia Satellite was first announced by the Prime Minister in 2014. India itself has been grappling with an old shortage of Ku-band transponders — because of which Indian DTH operators lease their capacity on private foreign satellites.

Asked about it, Mr. Kiran Kumar said sharing amidst scarcity was a generous act for the larger good.

Large solar storm sparks global aurora on Mars

An unexpectedly strong solar storm hit Mars this month, sparking a global aurora and doubling radiation levels on the red planet, Nasa scientists say.

The solar event on 11 September sparked an aurora more than 25 times brighter than any previously seen by the MAVEN orbiter, which has been studying the Martian atmosphere's interaction with the solar wind since 2014.

It produced radiation levels on the surface more than double any previously measured by the Curiosity rover's Radiation Assessment Detector (RAD) since that mission's landing in 2012. The high readings lasted more than two days. "Nasa's distributed set of science missions is in the right place to detect activity on the Sun and examine the effects of such solar events at Mars as never possible before," said ElsayedTalaat, programme scientist at Nasa headquarters in Washington.

Strangely, it occurred in conjunction with a spate of solar activity during what is usually a quiet period in the Sun's 11-year sunspot and storm-activity cycle. This event was big enough to be detected at Earth too, even though Earth was on the opposite side of the Sun from Mars.

"The current solar cycle has been an odd one, with less activity than usual during the peak, and now we have this large event as we're approaching solar minimum," said Sonal Jain of the University of Colorado Boulder's Laboratory for Atmospheric and Space Physics, who is a member of MAVEN's Imaging Ultraviolet Spectrograph instrument team.

"This is exactly the type of event both missions were designed to study, and it's the biggest we've seen on the surface so far," said RAD Principal Investigator Don Hassler of the Southwest Research Institute in the US. "It will improve our understanding of how such solar events affect the Martian environment, from the top of the atmosphere all the way down to the surface," Hassler said.

RAD monitored radiation levels inside the encapsulated spacecraft that carried Curiosity from Earth to Mars in 2011 and 2012 and has been steadily monitoring the radiation environment at Mars' surface for more than five years.

RAD findings strengthen understanding of radiation's impact on Mars habitability, a key objective of the Curiosity mission. Nasa is also using RAD findings for planning the safety of human-crew missions to Mars.

Highly energetic solar events can significantly increase the radiation that penetrates through the atmosphere to the Mars surface. The increased radiation also interacts with the atmosphere to produce additional, secondary particles, which need to be understood and shielded against to ensure the safety of future human explorers.

"If you were outdoors on a Mars walk and learned that an event like this was imminent, you would definitely want to take shelter, just as you would if you were on a space walk outside the International Space Station," Hassler said. "To protect our astronauts on Mars in the future, we need to continue to provide this type of space weather monitoring there," he said.

AstroSat's take on Crab nebula baffles astrophysicists

The Cadmium-Zinc-Telluride Imager (CZTI), an instrument to observe and image hard X-rays on board the Indian space observatory AstroSat, has consistently been making important observations since AstroSat's launch in 2015. The latest discovery, published in Nature Astronomy, is a polarization analysis of the Crab nebula pulsar

that has completely baffled astrophysicists studying pulsars.

Polarimetry

In this work, observations of the Crab pulsar made by CZTI have been analysed in the so-called phase-resolved X-ray polarimetry – a measure of the polarization of X-ray beams emanating from it. The experiment determines the magnitude and orientation of the polarization of the hard X-ray beams. This is the most sensitive and precise measurement of this variable until now. An analysis revealed that the values are contrary to what is predicted by all existing theories of pulsars.

Stars that have masses beyond a critical value of about 1.4 times the mass of our Sun will in the course of their lifetime explode to form a supernova. Even as some matter escapes from the explosion to create a glow, the remnant at the centre shrinks to become a black hole or a neutron star. The Crab nebula, in the Taurus constellation, is one such supernova remnant that has become a type of neutron star known as a pulsar. Known as the Crab pulsar, this emits electromagnetic radiation in a beam and also spins rapidly so that distant observers see the beam as a pulsating spot of light, justifying the name "pulsar."

Million cycles

"The Crab pulsar pulses once every 0.33 seconds and the data acquired by CZTI after observing millions of such 0.33-second cycles over a period of a year and half were analysed to get this result," says Varun Bhalerao of Indian Institute of Technology, Bombay, one of the researchers involved.

The pulses of radiation from the Crab pulsar show two peaked shapes coinciding with its north and south poles. In between these two high regions is a low-intensity, zero point called the off-pulse region. CZTI detected non-vanishing polarization having a definite varying structure in the off-pulse region where no variation was expected. "Since in the off-pulse region is dominated by radiation from the nebula [the cloud-like matter spreading away from the centre], the polarisation is expected to remain a constant here. But it certainly swings [varies with a definite shape]," says DrBhalerao.

Existing theories predict that there should not be such a variation of the polarisation. However, since the experiment has been repeated several times and the signs persist, it has forced theorists to rethink their theories of pulsars.

The extremely sensitive measurement was possible mainly because of the way the instrument was built and systemic errors were understood, he adds.

Here comes India's sun watcher Aditya-L1

With this advantage, the instrument has the capacity to observe the loop-like magnetic structures that form in the corona, the outer layer of the sun. "This will be the first experiment to measure the coronal magnetic field from a space platform. This was not even done by SOHO," says Dipankar Banerjee, the principal investigator of the VLEC.

Between them, the three payloads — VLEC, the Solar Ultraviolet Imaging Telescope (SUIT) and the X-ray spectrometers — can image the sun in all wavelengths.

Like seasonal changes on the earth, the sun experiences approximately eleven-year-long cycles during which sunspots, caused by the sun's magnetic field, start forming, increase in the ascending phase and decrease in the descending phase towards the end of the cycle.

"Studying coronal mass ejections [a phenomenon that would correlate with high sunspot activity] is not the only objective. This study can also help us understand the coronal heating problem," says Prof. Banerjee. The 'coronal heating problem' refers to the fact that the photosphere, a deeper layer of the sun, is at a much lower temperature than the outer layer, the corona. Since it is believed that the heating process happens from within, what causes this heating of the outer layer, the corona, remains a mystery.

First proposed in 2008 as a 400 kg-class satellite with one scientific instrument, a coronagraph, the project has since changed and grown in size and scope. Aditya-L1 will carry seven payloads. Each of these will either image the sun or sample the space around it for traces of charged particles spewed out by the sun during coronal mass ejections.

The payloads alone will weigh close to 250 kg. The biggest of these is the VLEC, about 170 kg. The next is SUIT, weighing around 35 kg; others are much lighter. Orbiting about the L1 point, due to a play of gravitational forces acting on it, Aditya-L1 will require little energy to keep it in place.

Bear-attack trends highlight need for conflict mitigation

It's not wild elephants or man-eating tigers, but sloth bears that cause the most number of human deaths in central India's Kanha–Pench wildlife corridor. An analysis of bear attacks in central India, published in PLOS ONE,

shows that there is an urgent need for conflict mitigation and improvement of compensation schemes for victims.

The sloth bear Melursusursinus is endemic to the Indian subcontinent. Studies show that the largest population of sloth bears is in Central India. The species is common in the 16,000 sq. km Kanha–Pench wildlife corridor which connects the Kanha and Pench tiger reserves in Madhya Pradesh. The corridor is also home to 442 villages; many families here depend on fuelwood and forest produce such as tendu leaves used to make bidis for sustenance and livelihood. This brings them in contact with bears frequently — 255 bear attacks occurred in the area between 2004 and 2016.

Scientists at the Corbett Foundation interviewed 166 survivors of bear attacks from 120 villages in the Kanha–Pench corridor. Their results reveal that more than 80% of the attacks occurred in the forest, where the victims had gone to collect fuelwood and forest produce or graze their livestock; more than half of the victims did not see the bears before they attacked. Collectors entered forests in large numbers and engaged in the gathering activities silently and separately, increasing the chances of sudden encounters with sloth bears, write the authors.

Gathering information about the victims' socio-economic status, the team found that almost three-quarters of the victims were from the Baiga and Gond tribal communities.

While the State government provides compensation to victims of wildlife attacks, more than 80% received amounts as low as Rs.5,000 regardless of wound severity or gender; more than half the victims bore their medical expenses themselves. Victims unfamiliar with the process of applying for compensation were also at a huge disadvantage.

Apart from generating awareness of compensation schemes, ground models to improve conflict mitigation are key because sloth bears use not only forests but also human-dominated landscapes outside protected areas, write the scientists.

"We have conducted workshops in 30 villages on how best to avoid sudden confrontations," says lead author AniruddhaDhamorikar. The Madhya Pradesh government has also increased animal attack compensation rates since February 2016.

India calls for stronger treaties to protect space assets

Stressing international cooperation in space as in all domains of global commons, Foreign Secretary S. Jaishankar called for strengthening global treaties to protect space-based assets and prevent militarisation of outer space.

"International cooperation is critical in the space domain as in other global commons. Our approach therefore goes beyond national considerations. In fact, it is not an exaggeration to state that international cooperation is today hard-wired into India's space programme," Dr.Jaishankar said addressing a conference on the space programme jointly organised by the Indian Space Research Organisation (ISRO) and the Federation of Indian Chamber of Commerce and Industry.

Over 200 treaties

In line with this, Dr.Jaishankar said India had more than 200 international cooperation agreements with more than 40 countries and international organisations, and called the maiden moon mission, Chandrayaan-I, a "successful example of international cooperation with international payloads".

"The South Asia satellite is a matter of particular pride as it literally raises the heights to which we had taken our 'neighbourhood first' policy," the Foreign Secretary said.

In May, ISRO launched the communications satellite GSAT-9, also called SAARC satellite, meant to provide connectivity and disaster support to countries in South Asia.

The satellite cost around Rs. 235 crore and had a life span of 12 years.

Saying India is party to all the legally binding instruments on outer space, Dr.Jaishankar said, "India has also noted with concern the growing diverse threats in this frontier and is sensitive to these challenges."

In a first, air-launched BrahMos missile test-fired

In a first, India successfully test-fired the air-launched version of the BrahMos supersonic cruise missile from an IAF Su-30MKI aircraft.

BrahMos, which is multi-platform, multi-mission missile, is now capable of being launched from land, sea and air and completes the tactical cruise missile triad.

"The air-launched BrahMos missile is a 2.5 ton supersonic air-to-surface cruise missile with ranges of more than 400 km. The IAF is the first Air Force in the world to have successfully fired an air-launched 2.8 Mach surface attack missile of this category," the IAF said.

The missile was gravity-dropped from the Su-30MKI from its fuselage, and the two stage engine fired up and propelled towards the intended target, a ship, in the Bay of Bengal.

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Heaviest weapon

BrahMos weighing 2.5 ton is the heaviest weapon to be deployed on the Su-30 fighter aircraft which was modified by the Hindustan Aeronautics Limited (HAL) to carry the weapon.

"This success not only bolsters the combat effectiveness of IAF but also demonstrates the capabilities of indigenous onboard avionics with innovative algorithms developed by DRDO," said Dr. G. Satheesh Reddy, Scientific Advisor to Defence Minister and Director General, Missiles and Strategic Systems.

The integration of the missile on the aircraft was a complex process involving mechanical, electrical and software modifications on the aircraft. In fact, the test launch had been delayed by the complexities in the integration. The software development of the aircraft was undertaken by the IAF engineers. "One of the major challenges overcome by the scientists of the Research Centre Imarat, DRDO in the missile development was optimisation of transfer alignment of the inertial sensors of the missile," the IAF said.

Original range

The land and sea variants of BrahMos are already operational with the Army and the Navy. The original range was 290 km in line with the limitations of the Missile Technology Control Regime. After India joined the grouping in June 2016, the range was extended to 450 km and would be further extended to 600 km.

BrahMos is a joint venture with Russia and named after the Brahmaputra and Moskva rivers. The development trials of an anti-shipping variant began in 2003 and combat trials in 2005.

The significance of the development is that in an increasingly complex air defence environment, the missile gives long stand-off distance to the IAF to strike targets deep inside the enemy territory and get away quickly.

'BrahMos increases strike range'

The successful test of the air-launched BrahMos cruise missile greatly enhances India's strike range not just on the borders but across the Indian Ocean, a senior official intimately involved in the project said.

"China is increasing its presence in the Indian Ocean to safeguard its critical energy lanes. If fired [BrahMos] from Andaman and Nicobar islands, the whole of Malacca Straits gets within striking range. With BrahMos now on Su-30MKIs even Gwadar gets compromised. It gives striking range," the official said.

The air-launched version of the BrahMos was successfully tested for the first time from a modified Su-30MKI of the Indian Air Force (IAF).

An officer observed that the BrahMos inherently gave the capability to strike deep across the borders to take on high value targets without crossing the border. "With the air variant, the strike envelope is further widened and can be executed at short notice," the officer added.

Right to access Internet non-negotiable: India

Union Minister for Electronics and IT Ravi Shankar Prasad said that the right to access the Internet is non-negotiable and no single entity can have a monopoly over this. Mr. Prasad's comments follow the U.S. proposal to roll back earlier rules related to open internet, clearing the way for service providers to charge users differently based on content or restrict access to some content.

"The right of access is not negotiable," the Minister said.

Sri Lankan Prime Minister RanilWickremesinghe stressed the need for ensuring Net neutrality while pointing out that the right had come under serious challenge in many parts of the world.

ISRO opens doors to private sector

In an attempt to increase the number of satellite launches and build the capacity of the private sector, the Indian Space Research Organisation (ISRO) issued a tender to the private industry for Assembly, Integration and Testing (AIT) of 30-35 satellites.

"ISRO has issued a Request For Proposal (RFP) to the private industry to build 30-35 satellites over three years. Under this, 4-5 companies would be selected after evaluation and awarded parallel contracts. They would be responsible for the AIT of satellites at ISRO facilities," said Dr. M. Annadurai, Director ISRO satellite centre. He was speaking at the first international seminar on Indian space programme jointly organised by ISRO and the Federation of Indian Chamber of Commerce and Industry.

He said ISRO currently launches 3-4 launches per year but the demand is for 16-18 satellites. ISRO expects to get the responses to the RFP by December 5, complete selection of the companies by January 5 and sign contracts by February5.

"The aim is to launch 3-4 satellites in 2018 and improve it further," Dr.Annadurai said to a question from The Hindu.

Gaining experience

Another ISRO official said it had tried this model on a pilot scale with two satellites. "Alpha Design Technolo-

gies was allowed to build satellites at our facilities. We did the hand holding on the first one and tried their staff. The second satellite was completely built by them at our facility," he said.

In the next step, the idea is to let the private industry build their own facilities after gaining enough expertise, the official added. The private sector already supplies majority of the sub-systems in satellite manufacturing.

Giving the reason for the push, he said in the next 3-4 years ISRO plans to launch 58 satellites. "Our in-house capacity is limited. So we are looking to offload 30-40% of the work to the private sector,"

To this end, ISRO has built a space technology park spread over 25 acres in Bengaluru where the entire range of facilities have been set up for use by the industry.

The theme of the seminar was 'Aerospace Manufacturing in India-Vision 2030.'

ISRO already has a partnership with private industry to produce satellites. The IRNSS-1H communication satellite aboard the ill-fated PSLV C-39 was the first to be produced by a consortium of six companies.

Dr. Sivan said ISRO had a partnership with about 500 domestic industries for the supply of various components and devices. "About 80% of the cost of launch vehicles and 40% of satellites are handled by these industries".

He stressed on the need for industry to reduce the manufacturing and material cost without compromising on quality to bring down the launch cost. ISRO, he said, had tightened tolerance to error following the failure of the PSLV- C39 mission.

Liquid Propulsion Systems Centre (LPSC) Director S. Somanath said the industry partnership for satellite production had paved the way for the transition to industry-made launch vehicles. He said automation and the increased use of composites and additives were turning the conventional manufacturing process on its head. "Reusable launch vehicles promise to bring down launch cost but pose a problem for industry due to lower demand. The solution is to create a market for more missions."

'PSLV built by domestic industry by 2020'

The Indian Space Research Organisation (ISRO) is preparing to hand over the entire gamut of launch vehicle manufacture to domestic industry by 2020.

"Until now, public and private industries have only supplied devices, components and sub-systems for ISRO's launch vehicles, including the PSLV and the GSLV. Our effort is to give a push to industry for production of end-to-end systems. By 2020, we hope to have the first completely industry-built PSLV," Vikram Sarabhai Space Centre (VSSC) Director K. Sivan said here.

Consortium of companies

Inaugurating the National Aerospace Manufacturing Seminar (NAMS 2017) organised by the Society of Aerospace Manufacturing Engineers, he said efforts were on to set up a consortium of companies for the purpose. "Ultimately, we hope to see industry make the transition from vendors supplying parts, to partners providing integrated systems".

Nasa contracts Uber to build flying taxi air control software

Uber has struck a deal with Nasa to develop software for managing "flying taxi" routes in the air along the lines of ride-hailing services it has pioneered on the ground, the company said.

And in this case, it's working hard to stay on regulators' good side.

Uber said it was the first formal services contract by the US National Aeronautical and Space Administration (NASA) covering low-altitude airspace rather than outer space. Nasa has used such contracts to develop rockets since the late 1950s.

Chief product officer Jeff Holden also said Uber would begin testing four-passenger, 200-miles-per-hour (322-km-per-hour) flying taxi services across Los Angeles in 2020, its second test market after Dallas/Fort Worth.

Holden is set to reveal the company's latest air taxi plans at Web Summit, an annual internet conference taking place in Lisbon this week.

"There is a reality that Uber has grown up a lot as a company," Holden said in an interview ahead of his speech. "We are now a major company on the world stage and you can't do things the same way where you are a large-scale, global company that you can do when you are a

small, scrappy startup."
Uber has faced endless regulatory and legal battles around the world since it launched its ride-hailing services earlier this decade, including a recent showdown in London, where it is battling to retain its licence after having been stripped of it by city regulators over safety concerns.
The company is looking to speed development of a new industry of electric, on-demand, urban air taxis, Holden said, which customers could order up via smartphone in ways that parallel the ground-based taxi alternatives it has popularised while expanding into more than 600 cites since 2011.
The company plans to introduce paid, intra-city flying taxi services from 2023 and is working closely with aviation regulators in the United States and Europe to win regulatory approvals toward that end, a senior Uber executive told Reuters.
"We are very much embracing the regulatory bodies and starting very early in discussions about this and getting everyone aligned with the vision," he said of Uber's plans to introduce what he called "ride-sharing in the sky".
Earlier this year, Uber hired Nasa veterans Mark Moore and Tom Prevot to run, respectively, its aircraft vehicle design team and its air traffic management software programme.
During a 32-year career at Nasa, Moore pioneered its electric jet propulsion project which Uber considers to be the core technology for making urban air transportation possible.

Making taxis fly

The contract with NASA is to solve the problem of operating hundreds or thousands of aircraft over urban areas with the goal of enabling uberAIR services to operate alongside existing air traffic control systems and in and around busy airports.
NASA was not immediately available to comment on the deal. Earlier this month it said it was working with a variety of companies, large and small, to develop the emerging market for what it terms Urban Air Mobility, or UAM.
Uber envisions a fleet of electric jet-powered vehicles — part helicopter, part drone and part fixed-wing aircraft — running multiple small rotors capable of both vertical takeoff and landing and rapid horizontal flight.
Two larger rotors used to lift the plane transition during flight into forward-thrusting propellers in newly released designs.
It plans to build no aircraft itself.
Instead, Uber is building the software to manage networks in the sky of flying taxis, while relying on a stable of manufacturers, including Aurora Flight Sciences, which was acquired by Boeing last month.
Uber has also signed up Embraer, Mooney, Bell Helicopter — a unit of Textron —, and Pipistrel Aircraft to build new vertical takeoff and landing aircraft.
It is also working with real estate developers Sandstone Properties in Los Angeles to build rooftop landing pads on skyscrapers from which it aims to offer its uberAIR services. It plans to start offering services from locations near a downtown sports arena, the international airport, Santa Monica and Sherman Oaks in suburban San Fernando Valley, the company said.

Hubble spots 'holiday ornament in space': Nasa

Scientists at Nasa using the Hubble Space Telescope have spotted what looks like a colourful holiday ornament in space—a planetary nebula with glowing wisps of outpouring gas that are lit up by a central star nearing the end of its life.
When a star ages and the red giant phase of its life comes to an end, it starts to eject layers of gas from its surface leaving behind a hot and compact white dwarf. Sometimes this ejection results in elegantly symmetric patterns of glowing gas, but the nebula named NGC 6326 is much less structured.
This object is located in the constellation of Ara, the Altar, about 11,000 light-years from Earth, according to Nasa.
Planetary nebulae are one of the main ways in which elements heavier than hydrogen and helium are dispersed into space after their creation in the hearts of stars.
Eventually some of this out-flung material may form new stars and planets. The picture was created from images taken using the Hubble Space Telescope's Wide Field Planetary Camera 2.
The vivid blue and red hues come from material including ionised oxygen and hydrogen glowing under the action of the fierce ultraviolet radiation from the still hot central star.

Artificial intelligence finds solar system with 8 planets like ours

A solar system with as many planets as our own has been discovered with the help of NASA's Kepler space telescope and artificial intelligence, the US space agency said. "Our solar system now is tied for most number of planets around a single star," NASA said in a statement.
However, none of the planets are expected to be hospi-

table to life. The eight-planet system—the largest known outside of ours—orbits a star called Kepler 90 some 2,545 light-years away.

"The Kepler-90 star system is like a mini version of our solar system," said Andrew Vanderburg, an astronomer at the University of Texas at Austin. "You have small planets inside and big planets outside, but everything is scrunched in much closer."

The newly identified planet, Kepler-90i, is a rocky planet like Earth, but orbits its star once every 14.4 days, meaning a full year there is the same as two weeks on Earth. "Kepler-90i is not a place I'd like to go visit, though," said Vanderburg. "Its surface is likely far too hot."

NASA calculated its average temperature at about 426 degree Celsius—as hot as Mercury, the closest planet to the Sun. Scientists found it by using machine learning from Google.

The process involved teaching a computer to scan a trove of 35,000 possible planetary signals collected from NASA's Kepler Space Telescope for search for signs of planetary transits. Transits are the dimming of light when planets pass in front of a star.

The Kepler Space Telescope launched in 2009, and has scanned some 150,000 stars. Astronomers have already confirmed the existence of some 2,500 far-away worlds using Kepler data.

"I became interested in applying neural networks to astronomy when I learned that the Kepler mission had collected so much data that it was impossible for scientists to examine it all manually," said Christopher Shallue, a senior software engineer with Google's research team.

"Instead scientists selected the strongest signals, which are the most likely to be actual planets, to receive the most attention." Shallue likened this process to "looking for a needle in a haystack." "Machine learning really shines when there is too much data for humans to examine for themselves."

More planets are expected to be found, because researchers plan to apply their neural network to Kepler's full set of more than 150,000 stars.

"There is a lot of unexplored real estate in the Kepler 90 system," said Vanderburg. "It would almost be surprising to me if there weren't any more planets in around that star." One day, artificial intelligence might even be used to search specifically for more Earth-like planets, which have proven difficult to pin down.

"For the first time since our solar system planets were discovered thousands of years ago, we know for sure that the solar system is not the sole record holder for the most planets, and we have just scratched the surface," Vanderburg added.

"Maybe there are systems out there with so many planets that they make our eight-planet solar system seem ordinary." The findings are published in The Astronomical Journal.

Most distant black hole discovered: Nasa

Scientists have discovered the farthest known supermassive black hole—a matter-eating beast that is 800 million times the mass of our Sun.

Astronomers combined data from Nasa's Wide-field Infrared Survey Explorer (WISE) with ground-based surveys to identify potential distant objects to study, then followed up with Carnegie Observatories' Magellan telescopes in Chile. Researchers identified candidates out of the hundreds of millions of objects WISE found that would be worthy of follow-up with Magellan. "This black hole grew far larger than we expected in only 690 million years after the Big Bang, which challenges our theories about how black holes form," said Daniel Stern of Nasa's Jet Propulsion Laboratory in the US.

For black holes to become so large in the early universe, astronomers speculate there must have been special conditions to allow rapid growth—but the underlying reason remains mysterious. The newly-found black hole is voraciously devouring material at the centre of a galaxy—a phenomenon called a quasar. This quasar is especially interesting because it comes from a time when the universe was just beginning to emerge from its dark ages. The discovery will provide fundamental information about the universe when it was only 5% of its current age.

"Quasars are among the brightest and most distant known celestial objects and are crucial to understanding the early universe," said Bram Venemans of the Max Planck Institute for Astronomy in Germany. The universe began in a hot soup of particles that rapidly spread apart in a period called inflation. About 400,000 years after the Big Bang, these particles cooled and coalesced into neutral hydrogen gas. However, the universe stayed dark, without any luminous sources, until gravity condensed matter into the first stars and galaxies. The energy released by these ancient galaxies caused the neutral hydrogen to get excited and ionise, or lose an electron.

The gas has remained in that state since that time. Once the universe became re-ionised, photons could travel freely throughout space. This is the point at which the universe became transparent to light. Much of the hydrogen surrounding the newly-discovered quasar is neutral.

That means the quasar is not only the most distant—it is also the only example we have that can be seen before the universe became re-ionised.
"It was the universe's last major transition and one of the current frontiers of astrophysics," said Eduardo Banados, astronomer at Carnegie Observatories in the US.

Nasa successfully fires Voyager 1 thrusters after 37 years

Nasa's Voyager 1 spacecraft—cruising interstellar space billions of miles from earth — was back on the right track thanks to thrusters that were fired up for the first time in 37 years.
The unmanned spaceship was launched along with its twin, Voyager 2, more than 40 years ago to explore the outer planets of our solar system, travelling further than any human-made object in history.
But after decades of operation, the "attitude control thrusters" that turn the spacecraft by firing tiny "puffs" had degraded. The small adjustments are needed to turn Voyager's antenna toward earth, allowing it to continue sending communications.
"At 13 billion miles from Earth, there's no mechanic shop nearby to get a tune-up," Nasa said in a news release.
Experts at the agency's jet propulsion laboratory (JPL) in California decided to turn to four backup thrusters that were last used on 8 November 1980.
"The Voyager flight team dug up decades-old data and examined the software that was coded in an outdated assembler language, to make sure we could safely test the thrusters," said Chris Jones, chief engineer at JPL.
The engineers fired up the thrusters and tested their ability to turn Voyager using 10-millisecond pulses. Then they waited 19 hours, 35 minutes for the test results to arrive at an antenna in Goldstone, California.
Turns out the thrusters worked just fine.
"The Voyager team got more excited each time with each milestone in the thruster test. The mood was one of relief, joy and incredulity after witnessing these well-rested thrusters pick up the baton as if no time had passed at all," said Todd Barber, a JPL propulsion engineer.
Being able to use the backup thrusters means the lifespan of Voyager 1 has been extended by two or three years, added Suzanne Dodd, project manager for Voyager.
Nasa plans to switch over to the formerly dormant thrusters in January. They will likely also conduct similar tests on the backup thrusters on Voyager 2.
Scientists still hear from the Voyager spacecraft daily, and expect to get data for about another decade.
Astronomy textbooks were rewritten on a wide scale thanks to the Voyager spacecraft, which zoomed past Jupiter, Saturn, Neptune and Uranus.
The plutonium-powered spaceships will continue until they finally run out of fuel, and will then orbit in the centre of the Milky Way galaxy.

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ENVIRONMENT AND ECOLOGY

Deciphering the 2014 drought

In2014, India recorded a 12% seasonal rain deficit with a record drought in the month of June. Scientists from the Department of Meteorology and Oceanography at Andhra University studied the climate data and found that divergence of water vapour was one of the main reasons for the drought. The analysis of the moisture transport patterns revealed that convergence and divergence of water vapour are important factors governing the Indian summer monsoon rainfall (June to September). The results were recently published inClimateDynamics.

The main drivers

Data from June 1 to September 30 for the period 2000-2014 were collected from the Climate Forecasting System model at the Pune's Indian Institute of Tropical Meteorology (IITM) and National Centre for Environmental Prediction (NCEP) final analysis from the U.S. The data showed that all parts of the country had received scanty monthly rainfall at least once during the four months in 2014. The overall seasonal rainfall over India was 775.5 mm which is a 12% less than the normal.

The researchers examined the water vapour transport as earlier studies by others had shown it could affect rainfall. "We measured the water vapour transport along the surface layer of the earth to the region of troposphere with 300 millibar level of atmospheric pressure," explains Dr. B.R. Srinivasa Rao, research associate at the university and co-author of the paper.

The divergence of moisture flux could have caused the low rainfall in June which was only 57.5 % of the average. In August 2014, there was a break in monsoon with rainfall only over northeastern and central parts of India. The regions with rainfall showed convergence of moisture and in the areas with no rainfall there was divergence. In September, the rainfall over many parts of India showed significant increase and also excess in some parts. The overall rainfall was 108.1% of the average. These values support the contention that over the land, moisture flux has a major influence on rainfall.

"Our oceans are getting warmer and the temperature gradient between land and ocean is becoming increasingly less. So we need to study and analyse the mechanism of moisture availability to land from sea. Our study shows that by measuring the convergence and divergence patterns of the water vapours we can predict the rainfall and drought trends," says Prof. S.S.V.S. Ramakrishna from the Department of Meteorology and Oceanography at Andhra University and first author of the paper.

The other physical processes that cause drought were analysed. The El Nino effect on 2014 monsoon rainfall was very small as the air-sea coupling weakened the effect, resulting in ENSO neutral conditions.

Earlier studies had shown that there is only very small relationship between Indian monsoon seasonal rainfall and other factors. The intrusion of western Asian desert air towards central India was an important feature for the dry spells. This partially explains the lack of rainfall but not the normal or above average rainfall.

Thus the results of this study suggest that the process of water vapour transport is an important physical process influencing the monsoons. The magnitude of convergence agreed with the rainfall in quantity and divergence caused drought. The study emphasises that moisture flux should be taken into consideration for accurate prediction of future climate.

IISER's coloured cocoons

The dark-branded bushbrown butterfly (Mycalesis-mineus) is one of the most common species in South and Southeast Asia and is found throughout the year in India. These butterflies are known to produce two different coloured pupae – brown and green.

Scientists at the Indian Institute of Science Education and Research, Thiruvananthapuram have found relative humidity was one of the deciding factors which caused the change of colour. Brown pupae are more common in drier conditions and develop faster than green pupae. The results were recently published in the journal PLOS ONE.

Sixteen female butterflies were collected from the IISER Thiruvananthapuram campus and reared in lab conditions. They were released in cages with maize, wheat and ragi plants to lay eggs. Eggs were collected every two days along with the leaf blades and kept in plastic boxes to hatch out. The hatched caterpillars (larvae) were released on maize plants in insect growth chamber. In 20-25 days, the larvae transformed into a pupa.

The green pupae were formed mainly under the maize leaves, whereas the brown were almost exclusively found away from the leaves on substrates such as soil. "The pupal stage is the stationary phase and they are more vulnerable to predation. So it is important to camou-

flage. Merging with the background avoids detection and maybe an adaptive strategy in pupae," explains Harshad Vijay Mayekar, at IISER and first author of the paper. The insect growth chambers were maintained at a humidity of 85% corresponding to wet season in nature and 60% humidity for dry season. Brown pupae were more common at lower humidity, that is, drier conditions. "When the moisture is low, it assumes that it is dry season and prefers substrates like soil. Similarly high moisture means wet season when there is more green foliage. So the larva chooses to pupate on the leaves. It is unclear whether the colour is decided based on the substrate choice [leaf or soil]; or the colour is pre-decided and then the larva picks the suitable substrate. More studies need to be carried out to understand this colour selection system," says Dr. UllasaKodandaramaiah, scientist at IISER Thiruvanantha-puram and an author of the paper.

The brown pupae (18-20 days) were found to develop faster than the green ones (22-24 days). "The green colour is the result of the plant material the larva has chewed on and the colour is seen through the sheath. But it takes time and energy to produce the brown pigment. The fact that they developed faster was an interesting observation. We are further investigating this finding," adds Dr. Kodandaramaiah .

More species of snakehead fish found

Confusions over snakehead fish species identity need not bother ichthyologists any more, as a global digital database of the species has been developed.

A global collaborative initiative involving as many as 10 scientific institutions has barcoded these freshwater fish varieties, which got their name from their unique snake-like snout. The members of the species are found distributed from the Middle East to eastern Asia, Central and West Africa and the Nile.

Earlier, it was widely believed that there were 38 species in this group. However, DNA-level analysis showed that there were several more species than first thought. The species strength of snakeheads could be 53 or even more, said Rajeev Raghavan, Assistant professor of the Kerala University for Fisheries and Ocean Studies, Kochi, which is one of the partnering institutions in the project. The research findings were recently published in PLOS ONE.

New species

Snakeheads are of great demand in the domestic market for food as well as for ornamental purposes. Since these species are mostly found in the inland waterbodies, no data on their catch is available. It's mostly the brightly coloured ones from northeastern India that find their way into aquaria.

The barcoding also succeeded in identifying new species Channa from Assam, foothills of Bhutan, Myanmar and another one from Congo.

The analysis of the data revealed that the eastern Himalaya and the adjoining region of Myanmar were hotspots for snakehead diversity, as up to 10 snakehead species described during the last quarter century originated from this region, explained Dr. Raghavan.

Current status

India is currently home to 15 species of Channa and the species diversity could go up as more studies would be undertaken.

Four currently known species — Channabankanensis found in Indonesia and Malaysia, Channamarulius, Channastriata and Channagachua — found in the Indian subcontinent and parts of southeast Asia, are considered species complexes, where different species are currently known under a single name because their taxonomy is poorly known or studied, he explained.

More taxonomic studies on the species complexes are required for conservation purposes as many of the currently wide ranging species are listed as of "least concern" in the Red List of IUCN.

One of the criteria for assessing a species as of least concern is its wide distribution. The breaking down of the species complex into individual species may have a different story to tell about its distribution which may prompt the scientific community to think for more species-specific conservation programs, felt researchers.

IIT Guwahati uses superhydrophobic cotton to remove oil-spill

Removing up to 95% of oil-spill of different densities — light and heavy oils — repetitively at least 100 times using superhydrophobic (extremely water repelling) medical cotton has been demonstrated by a team of researchers led by Dr. Uttam Manna from the Department of Chemistry at the Indian Institute of Technology (IIT) Guwahati.

The researchers turned the medical cotton, which is extremely water absorbing, into a superhydrophobic (water contact angle of 157 degrees) material and used it for absorbing oil both in air and under water. The efficiency of absorption is very high — above 2,000 weight percentage for both heavy and light oils. This translates to one gram of the superhydrophobic cotton absorbing 20 grams of either heavy or light oils. The results were published in

the Journal of Materials Chemistry A.

The absorbed oil can be recovered through physical compression. The superhydrophobicity remained intact even when the cotton was manually compressed up to 1,000 times and subjected to other physical manipulations.

"The other important characteristic is its ability to absorb oil from three complex phases — light oil that floats in the air–water interface, sediment oil that settles at the bottom as it is heavy, and from water-in-oil emulsion," says Dr. Manna. The superhydrophobic property was intact even when exposed to UV light for ten days, the material was able to absorb oil from river and sea water, and extremely acidic (pH 1) and alkaline (pH 12) water.

Treating emulsions

While the cotton is able to efficiently absorb oil from water-in-oil emulsion, it is inherently incapable of removing oil from oil-in-water emulsion. In the case of water-in-oil emulsion, very little of water is present in oil and so it is easy to remove all the oil leaving the water behind. But in the case of oil-in-water emulsion there is very little of oil present. "Since there is more water present, the superhydrophobic material does not come in contact with oil and so will be unable to remove oil efficiently from oil-in-water emulsion," clarifies AdilMajeed Rather from the Department of Chemistry at IIT Guwahati and the first author of the paper.

Filtering oil

The researchers were able to achieve selective filtration of oil under water against gravity in the case of heavy oil that has settled at the bottom. To do this, the researchers plugged one end of a tube with the superhydrophobic cotton and dipped the tube so it comes in contact with the oil.

"Once in contact with the sediment oil, the cotton absorbs the oil and due to hydraulic pressure the oil gets removed from the cotton and accumulates inside the tube," says Dr. Manna. "So there is no need to apply pressure to collect the sediment oil from cotton."

In the case of gravity-driven filtration, heavy oil mixed with water is poured into a funnel, the tip of which is closed with the superhydrophobic cotton. The heavy oil settles to the bottom and comes in contact with the cotton which filters it leaving the water in the funnel. "This method can be used in industry to remove the oil component from water before letting out the waste water," says rather.

Cotton processing

The hydroxyl group seen in cotton is first modified with branched poly(ethylenimine (BPEI) to make it functionalised with amine group. A nanocomplex is prepared separately by mixing BPEI with dipentaerythritolpentaacrylate (5Acl) and added to the functionalised cotton. The nanocomplex provides essential topography and makes the cotton chemically reactive, thus making it possible to further optimise the appropriate chemistry of the material. The nanocomplex reacts with amine-based small molecules of choice to make the cotton hydrophobic to varying degrees.

"We can tune the hydrophobicity — from hydrophilic to superhydrophobic — by using different amine-containing small molecules," Dr. Manna says. "It is a green synthesis without the use of any catalyst or hazardous material. The process of making superhydrophobic cotton is a simple three-step process and scalable."

Hotspots of rattan found in Western Ghats

Scientists have discovered that non-protected areas near the Agastyamalai Biosphere Reserve, Silent Valley-Mukurthi National Parks and Coorg-Wayanad in the Western Ghats are hotspots of rattan or cane (light, flexible climbing palms) species. Urgent conservation attention in the face of threats including habitat loss and excessive harvesting would be critical here, warns a study published in Plant Diversity.

Distribution

Using location records from field studies and literature, scientists at Bengaluru's Asoka Trust for Ecology and Environment (ATREE) and Pune's Indian Institute for Science Education and Research (IISER) first mapped the distribution of all 21 endemic rattan species across the Western Ghats. At 19, the Western Ghats in Kerala and Tamil Nadu have the highest number of species.

The team then designated 'conservation values' (CV) for each species based on aspects such as the area it is found in and the commercial harvesting pressure it faces. Three species showed very high CV; the authors suggest that these be classified as endangered while three others becategorised as near-threatened and 15 as vulnerable for prioritising conservation action.

Utilising niche modelling to predict areas of high rattan diversity, the scientists also identified three rattan hotspots in the Western Ghats. All these areas fall outside existing protected area networks, where excessive unsustainable harvests could be a problem. Loss of tropical forest tracts to coffee and tea plantations — as is common in the Coorg-Wayanad complex — is also an issue, say the scientists.

"Forest department managers need to encourage farm-

ers to establish large-scale plantations in private lands and develop agro-forestry systems as well," says co-author Aravind N.A. (ATREE). "The Forest Department has already established a few rattan plantations in some districts... this needs to be replicated at a wider scale where the demand for rattan is high," says ATREE's G. Ravikanth, another co-author.

Bonnet macaques losing their ground in south India

It's tough times for south India's bonnet macaques — a monkey that we think is irritatingly common could be losing ground to the larger and more aggressive rhesus macaque of the north. Other factors contributing to their decline include rapid urbanisation (as roadside trees are felled and vegetation lost) and their disappearance from temples and tourist spots, says a study published inP-LOS ONE.

Bonnet macaques are endemic commensals: they are found only in peninsular India and live in close proximity with humans, adapting to habitats ranging from riverside temples to roadside fig trees. However, a study in 2011 suggested that rhesus macaques were invading the bonnet's habitats in south India.

Surveys

To assess the current status of bonnet macaques, a team of scientists from institutes including Tamil Nadu's Salim Ali Centre for Ornithology and Natural History (SACON) surveyed roadsides (1,140 km in total) in peninsular India which were considered the southernmost boundary for rhesus macaques and compiled distributional data from earlier studies in the area. They found that rhesus macaques have spread as far south as Karnataka's Raichur district — adding 24,565 sq km to their former range — in an area where bonnet macaques used to reside.

The team collated information on bonnet macaque presence from surveys between 1989 and 2015 along 651 km of Mysore's roadsides and found that over the last 25 years a staggering 65% of the population has disappeared. The scientists predict that many of these populations will go locally extinct in 10 years. High-resolution satellite and Google Earth imagery between 2000 and 2006 and from 2015 onwards showed a decrease in tree cover on and around these roads; the loss of contiguous canopies now prevents the monkeys from colonising new areas.

Vanishing numbers

Bonnet macaques were present only in low numbers across 16 forest-dominated protected areas that the team surveyed in south India. They also found that bonnet macaques have disappeared from more than 48% of temples and tourist spots across Kerala, Karnataka and Tamil Nadu. These areas are no longer stable habitats for these monkeys, write the scientists. "People are now less tolerant to bonnet macaques," says co-author H. N. Kumara, senior scientist at SACON. "Even in temples, they are captured and translocated elsewhere. If we can give them a little space, they will survive. We need to take more interest in these common and less-charismatic species before they decline like sparrows did."

Plant emissions higher than believed

Carbon released by plant respiration may be around 30% higher than previously predicted, a new study claims. The study, published in the journal Nature Communications, suggests that as the mean global temperature increases, respiration will increase significantly.

Future prospects

Such increases may lower the future ability of global vegetation to offset carbon dioxide emissions caused by burning fossil fuels. "Plants both capture carbon dioxide and then release it by respiration. Changes to either of these processes in response to climate change have profound implications for how much ecosystems soak up carbon dioxide emissions from burning fossil fuels," said lead author Chris Huntingford of Britain's Centre for Ecology and Hydrology.

"In fact, this study provides the most up-to-date accounting of respiratory carbon releases from plants in terrestrial systems," Peter Reich, Professor at University of Minnesota College of Food, Agricultural and Natural Resource Sciences in the US, said. The findings are based on the comprehensive GlobResp database, which is comprised of more than 10,000 measurements of carbon dioxide plant respiration from plant species around the globe.

Computer models

Merging this data with existing computer models of global land carbon cycling showed plant respiration has been a potentially underestimated source of carbon dioxide release.

"Once we incorporate this data into state-of-the-art carbon cycling models, we are much closer to being able to accurately model carbon cycle feedbacks for climates across the globe," Reich said.

Delay in the protection of corridors threatens tiger population

It is not just poaching or habitat loss that threatens India's

tiger population. Delayed action to protect crucial wildlife corridors — despite the availability of relevant ecological knowledge — is also killing these big cats, shows a study published in conservation journal Oryx.

For species like tigers which move across large distances, wildlife corridors, protected patches of land connecting two habitats, are crucial. Uttarakhand'sChilla–Motichur corridor is one such patch connecting the eastern and western tracts of the Rajaji Tiger Reserve. It is the only way tigers from the eastern tract (part of a larger, more connected landscape) can colonise the isolated western one. Over the years, however, the corridor has been deteriorating due to reasons including the expansion of nearby townships and the construction of a national highway and rail line.

Multi-pronged approach

Scientists at the Panthera, Nature Conservation Foundation and the University of Kent, U.K., used a multi-pronged approach to study the status of the Chilla–Motichur corridor. First, they studied tiger presence in the area using presence–absence surveys of tiger signs, assessing change in tiger presence from data gathered between 2002 and 2009. While the eastern tract showed a high presence of tigers, the western one showed a distinct decline in tiger numbers and presence.

Second, the team studied the corridor's connectivity using remotely-sensed night-time lighting as an indicator of urbanisation.

They found that since 1993, urbanisation had decreased opportunities to restore the effectiveness of the corridor considerably.

The team compiled 31 research articles on the corridor and made 14 distinct recommendations to restore corridor connectivity. Only five recommendations have been incorporated into government management plans, and delays in mobilising funds and approvals from state departments followed by the lack of deadlines to implement these actions exacerbated the problems.

"Institutional failings are mirrored in the inability of many state and central departments to work together for the restoration of Chilla-Motichur; this case typifies what happens with most wildlife corridors across the country," says lead author AbishekHarihar (Panthera and Nature Conservation Foundation). "If immediate action is not taken, the population in the western tract could go extinct."

Pre-monsoon dust aerosol loading reduces over north India

Though the aerosol burden over north India is three times more than the global mean value and has been increasing at about 3% per year for the past few decades, the amount of dust aerosol during the pre-monsoon period has decreased by 10-20% during the period 2000 to 2015.

"Past studies have shown that whenever pre-monsoon dust aerosol is more over north Indian region, the early part of monsoon rainfall is higher," says V. Vinoj from the School of Earth, Ocean and Climate Sciences at the Indian Institute of Technology (IIT) Bhubaneswar, Odisha. "Our study shows that dust aerosol loading is declining during pre-monsoon period, but the bad news is that rainfall may be reducing during early monsoon."

Besides gathering data from ground-based stations, the team of researchers led by Dr. Vinoj used satellite-based measurements from different platforms.

All five ground-based stations (AERONET sites) show a decreasing trend in the aerosol loading during the pre-monsoon period across the Indo-Gangetic Plain. Largest decrease has been over Jaipur and the least reduction was in eastern Uttar Pradesh. Since the amount of aerosol loading has been increasing in this region on an annual basis, the reduction registered at these stations must be due to decrease in dust aerosols, the researchers say. The results were published in the journal Scientific Reports.

"Maximum reduction [in terms of quantity] in total particulate loading during pre-monsoon period is seen in the northwest part of India. However, the eastern parts of India have witnessed the greatest percentage reduction in particulate loading," says Dr. Vinoj. "This indicates that the source of observed changes is towards the west."

Proof of dust reduction

The satellite-based measurements too indicate a reduction in aerosol loading during the pre-monsoon period over a large swathe of area over northwest India. Generally, satellite-based methodologies are not very good at distinguishing between aerosol types. However, the Ozone Monitoring Instrument (OMI) on board the Aura satellite, which is sensitive to absorbing aerosols, shows a decreasing trend. This indicates that the changes are related to dust and/or black carbon, both of which are more absorbing in nature.

Ground-based stations in Karachi, Lahore and Kanpur, which have the longest available data, show "significant reduction" in dust loading during 2000-2015. The decreases are 10-20% over all the sites.

The decrease in aerosol has been most pronounced in the areas west of the Indo-Gangetic Plain, with Jaipur

registering about 3% drop per year with respect to the year 2000, while Kanpur showing a relatively lower reduction of about 0.5%.

Based on aerosol size and absorption information collected from ground-based stations, the researchers have been able to confirm that the decreasing trend is due to dust particulates. MERRA2, a more sophisticated, model-based analysis, too, shows similar trends. "This is proof that it is dust which is reducing the total particulate loading during recent times," Satyendra K. Pandey from IIT Bhubaneswar and the first author of the paper.

The reason for a reduction in dust loading during the pre-monsoon period is due to increased rainfall, with maximum increase seen over Pakistan region and Thar desert, which is a dust-source region. The pre-monsoon rainfall makes the soil wet thereby reducing the amount of dust that gets emitted and also increases the removal of dust present in the atmosphere.

In addition, there has been a gradual slowdown in wind speed in the vicinity of Thar desert. "These two factors might be contributing to reduced dust loading during pre-monsoon period over north India," he says.

"In the last 10-15 years, the area under irrigation in Rajasthan has increased and so is the area under vegetation," says Prof. Vimal Mishra from the Civil Engineering department at IIT Gandhinagar, who is not part of this study.

Bear-attack trends highlight need for conflict mitigation

It's not wild elephants or man-eating tigers, but sloth bears that cause the most number of human deaths in central India's Kanha–Pench wildlife corridor. An analysis of bear attacks in central India, published in PLOS ONE, shows that there is an urgent need for conflict mitigation and improvement of compensation schemes for victims.

The sloth bear Melursusursinus is endemic to the Indian subcontinent. Studies show that the largest population of sloth bears is in Central India. The species is common in the 16,000 sq. km Kanha–Pench wildlife corridor which connects the Kanha and Pench tiger reserves in Madhya Pradesh. The corridor is also home to 442 villages; many families here depend on fuelwood and forest produce such as tendu leaves used to make bidis for sustenance and livelihood. This brings them in contact with bears frequently — 255 bear attacks occurred in the area between 2004 and 2016.

Scientists at the Corbett Foundation interviewed 166 survivors of bear attacks from 120 villages in the Kanha–Pench corridor. Their results reveal that more than 80% of the attacks occurred in the forest, where the victims had gone to collect fuelwood and forest produce or graze their livestock; more than half of the victims did not see the bears before they attacked. Collectors entered forests in large numbers and engaged in the gathering activities silently and separately, increasing the chances of sudden encounters with sloth bears, write the authors.

Gathering information about the victims' socio-economic status, the team found that almost three-quarters of the victims were from the Baiga and Gond tribal communities.

While the State government provides compensation to victims of wildlife attacks, more than 80% received amounts as low as Rs.5,000 regardless of wound severity or gender; more than half the victims bore their medical expenses themselves. Victims unfamiliar with the process of applying for compensation were also at a huge disadvantage.

Apart from generating awareness of compensation schemes, ground models to improve conflict mitigation are key because sloth bears use not only forests but also human-dominated landscapes outside protected areas, write the scientists.

"We have conducted workshops in 30 villages on how best to avoid sudden confrontations," says lead author AniruddhaDhamorikar. The Madhya Pradesh government has also increased animal attack compensation rates since February 2016.

Knowing our rivers better before changing them

Science is yet to understand the complexity of riverine ecosystems which are geologically, hydrologically and ecologically diverse, says JagdishKrishnaswamy, eco-hydrologist at Bengaluru's Ashoka Trust for Ecology and the Environment. He said this in connection with the need to understand our rivers better before embarking on large-scale river transformations like river linking and inland waterways.

The recent discovery of an entire freshwater river flowing through the Bay of Bengal (parallel to the eastern coast) is a classic case. Sustained by the waters of the Ganga, Brahmaputra and Godavari, this river has great consequences for biodiversity, ecosystem services and fisheries. "Some scientists' work suggests this could even affect the salt balance between the Arabian Sea and Bay of Bengal, possibly impacting climate regulation," he says.

This also changes the false discourse (used while constructing dams) that rivers draining their freshwater into the sea are a waste. Freshwater, sediments and nutrients

that flow into the sea help sustain mangrove, delatic and estuarine ecosystems, supporting marine fisheries. Embarking on huge transformations like linking rivers which reduces the flow of rivers into oceans and seas could affect ecosystems and livelihoods, says Dr. Krishnaswamy.
The lack of interdisciplinary research to study these river systems from economic, ecological, climate and hydrological perspectives could also force us to commit to large-scale transformations without having the knowledge of their consequences, he adds.
The after-effects of some of the large-scale river transformations could create more problems. Making rivers navigational channels, for instance, would involve dredging.In rivers like the Ganga, where sediment has been absorbing pollutants for a long time, there is already evidence that dredging causes the release of toxins including arsenic, says Dr. Krishnaswamy.
Underwater noise (sonar waves due to use of machinery) can interfere with the survival of India's national aquatic animal — the Gangetic dolphin — which relies solely on sonar and acoustics for survival. "This species has been doing really well considering the natural changes, and disturbances it has encountered for millions of years, but this one might be really difficult to cope with," he says.
The consequences of linking rivers vary from the spread of invasive fish like piranhas to transferring pollutants to intact river systems. "Homogenising our rivers also makes them less resilient to future climate change," he adds.
We need to consider all other options before drastically transforming our rivers, he adds. "Learning from a smaller-scale project before embarking on large-river linking schemes is important," he says. Other vital steps include preventing new dams on the last remaining free-flowing tributaries, as well as a shift to less water-intensive crops that will not only ease the pressure on rivers but also help in food and nutritional security.
The need of the hour is a transparent platform to assess the changes occurring in our river ecosystems. "Even though India is so dependant on its monsoons and rivers, it is really unfortunate, how little we know about the flow and sediment dynamics of our river systems," he says. "Even data that does exist is largely not accessible due to disputes between States or countries. We need to start now and establish river monitoring systems, sharing data [with all stakeholders] to understand the short- and long-term dynamics of our river systems."

Lizard genes reveal grasslands' antiquity

Earlier this year, India's less-known lacertid lizards gave scientists a sneak peak into the country's ecological past. Genes of these grassland-dwelling reptiles show that they evolved with the spread of arid Indian habitats around nine million years ago. These open habitats contain six times more lacertid species than currently known to science, highlighting the need to recognise India's oft-ignored native open habitats as unique biodiversity-rich habitats, shows the study published in the Journal of Biogeography.
Open arid habitats in India – such as savannas and grasslands – are often considered wastelands or degraded forests, despite the ecosystem services (including supporting diverse wildlife and large numbers of livestock) they provide. But are these grassy biomes natural or caused by early human activities like tree-felling and burning?
To trace the evolution of these biomes in India, scientists at the National Centre for Biological Sciences (NCBS) in Begaluru studied lacertids or wall lizards of the genus Ophisops which are restricted to India's open habitats. They collected genetic samples of these lizards from 108 locations across the country. Analysis of portions of three genes showed a hidden diversity: while only five Ophisopsarerecognised in India now, the scientists' results show that there could be at least 30 Ophisops here.
Using already-known dates of fossil lacertids, the team constructed a detailed evolutionary tree (using already-known dates of fossil lacertids). They find that the ancestors of Ophisops moved from Saharo-Arabia (parts of the Saharan desert, Arabian peninsula, Palestine and Mesopotamia) into India about 30 million years ago (late Oligocene period) and dispersed back to Saharo-Arabia around 19-10 million years ago (mid Miocene).
However, the current diversity of Ophisops we now see surged between nine and five million years ago, when arid climes caused grassy biomes to expand (palaeoclimatic records show an increase in C4 grasses adapted to warmer and drier habitats at this time). This increase in lacertid diversity due to grassland expansion shows that at least some parts of India had natural grasslands well before the earliest records of human activity, contrary to the notion that human activity created grassy biomes.
"The narrative is usually that open habitats were created by people but our study shows that is not true for all of India," says lead author Ishan Agarwal (formerly with Villanova University and NCBS). More field-based studies are crucial and open habitats need urgent conservation attention, he adds.

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How seasons drive a lizard's life

Winter blues and summer lows may be the only ways the weather affects human behaviour, but scientists have found that seasonal climatic changes govern the life cycle of a species of tropical lizard. The breeding of the rock agama shows a distinct annual cycle, tracking periods of hot weather and rain in its habitat. Changes in global climate, which can affect regional temperature and rainfall, could affect the biology of such cold-blooded reptiles, write the scientists.

While temperate systems show distinct seasons with climatic conditions varying drastically, the tropics are usually less variable. However, in some parts of the tropics, such as the Rishi Valley in southern Andhra Pradesh, the extremes are apparent. Here, summer temperatures peak between March and May ranging between 8-41 degree C, and rainfall is highly seasonal.

Scientists at the Indian Institute of Science (IISc), Bengaluru, studied how this seasonality affects the breeding of Peninsular rock agama (a tropical lizard found across rocky habitats in peninsular India) at Rishi Valley. The backs of male agamas turn a bright yellow–orange during the breeding season, while the bulging bellies of females are a sign that they are carrying eggs. Identifying these breeding characteristics of 205 tagged lizards across three years, the team also took physical measurements by recapturing some of these individuals and collated daily temperature and rainfall data from a local weather station.

Most males began displaying breeding colouration in May, when temperatures peaked, and lasted till September. The breeding season ended around September.

Meanwhile, the females began laying the first eggs in June–July, only after the first rains of the year. This could be possibly because the rains loosen the soil, helping them dig holes to lay their eggs. Juvenile lizards began emerging from September to December, mid-way into the monsoon when food resources are abundant. Censuses conducted by the team to arrive at lizard numbers in the area show the highest number of juveniles during November.

"The current year's juveniles were the breeding males the next year, hinting at a rapid growth to attain reproductive maturity," says ShreekantDeodhar, the lead author of the study published in Current Science . "But after that, they just disappeared. This annual pattern was unexpected because you would expect these large lizards to live longer than a year."

Though the team sampled all males of the population they studied, only very few were re-sighted and re-captured across breeding seasons; the species do not hibernate or migrate to other sites.

"Climatic changes could affect these cold-blooded reptiles faster, giving us an inkling of what could be happening with changes in global weather patterns," he adds.

RESEARCH-PENGUINS

Penguins may have lived in East Antarctica as far back as 14,600 years ago — 6,000 years earlier than thought. Chinese scientists analyseddeglacial sediment that dated back 15,600 years. Analysis of penguin excrement in the sediment showed that the birds came there 1,000 years after the ice sheet melted.

New endemic ants from the Andamans

There's more to the Andamans than magical beaches and colourful corals. Scientists have discovered two new ant species of the genus Tetramorium in the evergreen forests of the archipelago.

Scientists of the National Centre for Biological Sciences (NCBS), Bengaluru and the Okinawa Institute of Science and Technology Graduate University, Japan have discovered the new species Tetramoriumkrishnani and Tetramoriumjarawaduring a detailed island-wide survey of Havelock Island, a part of the Andaman archipelago. The species are named in honour of late scientist K.S. Krishnan of the NCBS, and after the Jarawas, an indigenous people of the islands, who are thought to have inhabited the islands for at least several thousand years.

The newly discovered ants dwell in leaf litter in the evergreen forests of Havelock Island and are endemic to the Andamans. In total, the study recorded the presence of 50 ant species, many of which have been recorded for the first time.

The study published in PeerJ also provides accounts of all Tetramorium ant species seen in India and an illustrated identification 'key' for these Indian species, which allows ant enthusiasts to use the distinct features of an ant to identify what species it belongs to.

In a first for India, the team used a novel X-ray micro CT technology to build 3D models of the ant specimens to observe anatomical structures in detail for easier taxonomic identification of the species. These 3D images can be mapped with the genetic profiles of species using the new technology to study the evolution of ant morphology.

"We are excited about the discovery, though we did expect to come across new species because we know very little about India's ant species, they are not well-docu-

mented," says Gaurav Agavekar, one of the authors. "I hope to sample other islands of the archipelago in future, as well as mainland India to generate quality baseline data for ants across the country, which can be used to answer interesting ecological and evolutionary questions."

Stressed-out worms sleep

When you catch a cold, curling up in bed to sleep is the only activity you can manage. Sleeping in response to stress isn't a uniquely human behavior: many animals have the same reaction, and it's not clear why. Researchers now report stress-induced sleep in the nematode worm Caenorhabditis elegans using ultraviolet C radiation to induce stress. They found that after exposure to UV C radiation, the worms initially wriggled more,but then their movements slowed as if they were dozing off. Sleeping after stressful events helps the organism funnel more resources into cellular repair. Still, the restorative properties of sleep -- stress-induced or otherwise--remain to be fully understood.

Govt plans to set up bio-CNG plants and allied infrastructure

To promote the use of clean fuel, the oil ministry plans to set up bio-CNG (compressed natural gas) plants and allied infrastructure at a cost of Rs7,000 crore, two people aware of the plan said.

The oil ministry will be working with state-run oil and gas retailers to set up the plants over the next two years, the people said on condition of anonymity.

Bio-CNG is a purified form of biogas with over 95% pure methane gas. It is similar to natural gas in its composition (97% methane) and energy potential. While natural gas is a fossil fuel, bio-CNG is a renewable form of energy produced from agricultural and food waste.

Bio-CNG is being looked at as an environment-friendly alternative to diesel.

Indian Oil Corp. Ltd, Bharat Petroleum Corp. Ltd and Hindustan Petroleum Corp. Ltd are the state-run oil marketing companies that the oil ministry will team up with to implement the plan. Gas marketer GAIL India Ltd will also be involved.

"The government would be setting aside around Rs7,000 crore to set up infrastructure for bio-CNG. The funding could be channelled through the oil and gas marketing companies," said an official with an energy firm, one of the two people cited above.

"The government's plan is to make India a gas-based economy. In addition to other alternatives, setting up of multiple bio-CNG plants in the country is part of this goal," said the second person, a senior official from one of the oil marketing companies.

Indian Oil, Bharat Petroleum and Hindustan Petroleum did not reply to emails sent on 22 December.

Setting up the infrastructure would be a priority. A typical bio-CNG station comprises a biogas purification unit, a compressor and a high pressure storage system.

"Unless infrastructure is in place, lifting of the fuel will not happen so government and companies have to ensure there are no infrastructure bottlenecks," said the first person.

The cost of production of 1kg of bio-CNG could be Rs15-20, cheaper than CNG, petrol and diesel.

Transportation of bio-CNG could either be through injecting the fuel into the CNG grid or by trucks or in cylinders from the filling stations.

India currently imports one-third of its energy requirement. The world's third-largest crude oil importer is targeting halving its energy import bill by 2030. The government aims to increase the contribution of gas in India's energy mix to 15% from the current 6.5%.

Carbon dioxide levels hit record high in 2016: WMO report

Concentration of carbon dioxide in the earth's atmosphere rose at a record-breaking speed in 2016 to reach the highest level in 800,000 years, a report by the World Meteorological Organization (WMO) said. The development, it said, has the potential to initiate unprecedented changes in climate systems, causing severe ecological and economic disruptions.

The WMO's 'Greenhouse Gas Bulletin', released , said the abrupt changes in the atmosphere witnessed in the past 70 years are without precedent.

As per the report, globally averaged concentrations of CO2 reached 403.3 parts per million (ppm) in 2016 up from 400.00 ppm in 2015 because of a combination of human activities and a strong El Niño event. Concentrations of CO2 are now 145% of pre-industrial (before 1750) levels.

The report emphasized that the last time the Earth experienced a comparable concentration of carbon dioxide was 3-5 million years ago when the temperature was 2-3°C warmer and sea level was 10-20 meters higher than now.

It warned that rapidly increasing atmospheric levels of CO2 and other greenhouse gases have the potential to initiate unprecedented changes in climate systems, leading to severe ecological and economic disruptions.

It underlined factors like population growth, intensified agricultural practices, increases in land use and deforestation, industrialization and associated energy use from fossil fuel behind the unprecedented increases in concentration of greenhouse gases in the atmosphere since the industrial era, beginning in 1750.

According to the report, the rate of increase of atmospheric carbon dioxide over the past 70 years is nearly 100 times more than that at the end of the last ice age.

Methane, another major greenhouse gas, reached a new high of about 1853 parts per billion (ppb) in 2016 and is now 257% of the pre-industrial level.

The levels of nitrous oxide, another greenhouse gas, too reached new highs. Its atmospheric concentration in 2016 was 328.9 parts per billion which is 122% of pre-industrial levels.

"Without rapid cuts in CO2 and other greenhouse gas emissions, we will be heading for dangerous temperature increases by the end of this century, well above the target set by the Paris climate change agreement. Future generations will inherit a much more inhospitable planet," said WMO secretary-general Petteri Taalas in an official statement.

"CO2 remains in the atmosphere for hundreds of years and in the oceans for even longer. The laws of physics mean that we face a much hotter, more extreme climate in the future. There is currently no magic wand to remove this CO2 from the atmosphere," he added.

The report comes ahead of the UN climate change negotiations that are scheduled to be held from 7-17 November in Bonn, Germany.

Counting the tigers that roam a water world

In the Sundarbans, tigers are everywhere and nowhere, says Amitava Ghosh in his book The Great Derangement, Climate Change and the Unthinkable .

Camouflaged in the mangrove forest and living in a unique water-dominated habitat with a minimal prey base, the Sundarbans tiger remains one of the most mysterious animals.

One of the questions that forest officials and scientists have been grappling with for decades is this: how can tigers be counted in the Sundarbans? Until a few years ago, it was impossible to get an estimate with existing techniques. While individual estimation of tigers was out of the question, tides twice a day in the region (high tide and low tide at an interval of 12 hours) made identification by pugmarks and fecal DNA extremely difficult.

In 2006-07, attempts to set up camera traps were unsuccessful as saline water entered the camera, destroying the equipment. The traps were placed at knee height.

It is only after 2014 that camera traps began to give positive results, and the latest results have been encouraging. With years of experience and trial and error methods, forest officials and experts found strategic locations to put camera traps in the Sundarbans, in the higher areas of the forests not inundated during high tide. The camera traps are set about 40 cm to 50 cm above the ground here.

The photographs reveal 87 'adult individuals' in the Sundarbans, a significant increase from the earlier camera trap exercises. Earlier, camera traps yielded photographs of about 62-63 adult tigers.

"In 2015, we got photographs of 63 adult tigers. Six of them could not be located this year. Fifty-seven of the remaining tigers were located once again using the camera traps. We also got photographs of 30 new adult tigers, taking the number to 87," Ravi Kant Sinha, Principal Chief Conservator of Forests and Chief Wildlife Warden, West Bengal, told The Hindu .

Mr. Sinha said with a minimum of 87 adult tigers (cubs were not included), the ecosystem with a potential tiger area of 3,200 sq km can host more than a hundred tigers. 'The Status of Tigers in India 2014', published in 2015, stated, "Sundarbans has now been camera trapped with 62 unique individual tigers photo-captured." According to the report, "Tiger population in the Sundarbans has remained stable and is estimated to be about 76 (62 to 96) tigers."

Officials, including Mr. Sinha, say tiger estimation in the unique habitat is still a work in progress and only over the next few years — with more results of camera traps — could a more precise number be ascertained.

Software analyses photos

These camera trap images are fed into software which uses statistical extrapolation based on the number of days and the images to come up with a tiger number. Since each tiger has a unique pattern of stripes, the images help count adult tigers. In every assessment, some new tigers are found and some are recaptured. Some tigers which were photographed earlier may not appear again.

The results of the camera trap exercise pointed to the presence of 24 tigers in South 24 Parganas forest division, which is outside the Sundarbans Tiger Reserve Area. In this region, which is closest to human habitation, 10 new adult individuals were photographed in the latest

estimate. Images of 16 adult tigers were captured in the National Park East Range, 19 in the West Range and 15 each in the Basirhat Range and the Sajnekhali Wildlife Sanctuary. In each of the tiger zones, there was a minimal increase of at least five adult tigers.

The camera traps also revealed that two tigers captured in the Basirhat range were recaptured in the Sajnekhali Wildlife Sanctuary.

Yet, experts admit that estimations by camera traps have limitations in the Sundarbans, particularly because of tidal variation leading to inundation in large parts of the tiger ecosystem and difficulty of access to remote areas of the forest to set up camera traps.

Experts and forest officials said the number of tigers which the ecosystem can accommodate may also be estimated using the prey base.

Wild pig main prey

The Sundarban tiger's main prey is the wild pig, said BiswajitRoychowdhury, Secretary, Nature Environment & Wildlife Society (NEWS). A number of tiger scats were examined and found to contain pig hair. They also eat swamp deer, rhesus monkey, monitor lizards, and even crabs and fish. The region is the only forest in India where no cattle or other easy prey is available to tigers, which forces them to swim across water channels.

Mr. Sinha said that to get an estimate of the prey base, even the fish in the region would have to be taken into account. According to Mr. Roychowdhury, if tigers here regularly feed on fish, it would place the tiger atop both the terrestrial and aquatic food chain.

In July 2009, the remains of two cobras, a king cobra and a monocled cobra were found in the stomach of a 12-year-old dead tigress, an anomalous occurrence as the big cats are not known to eat venomous snakes. There were no external injuries on the body of the tigress and its lungs, liver and spleen were found to be infected. But forest officials could not confirm that it was snake venom that resulted in its death.

Tiger behaviour

The elusive nature of the tiger here has led to many questions on its behaviour.

A paper titled Ranging, Activity and Habitat Use by Tigers in the Mangrove Forests of the Sundarbans, published in April 2016 in PLoSOne, a peer-reviewed journal by researchers Dipanjan Naha, Yadvendradev V. Jhala, Qamar Qureshi, Manjari Roy, KalyansundaramSankar and Rajesh Gopal sheds some light.

"It appears that tigers moved most during dawn and the early morning hours. Sunrise in the Sundarbans region was between 4.45 a.m. and 6 a.m. and tiger activity coincided with this period," the paper states.

Tigers are nocturnal and try to avoid confrontations with humans, and the paper suggested that if human activity were reduced in the early morning hours, attacks by tigers could potentially be reduced.

An estimate provided by the Forest Department claims that tigers, between 1985 and 2010, attacked 410 people, leaving only 95 survivors.

Post-2010, the number of tigers straying and attacks on human decreased. The latest figure of deaths from attacks by Sundarban tigers in 2014-15 is 10. Even in July 2017, a tiger from the forest jumped on a boat carrying a fisherman and took away 62-year-old Sushil Majhi into the deep forests. In another instance this year, a tiger which had strayed near human habitation was released in South 24 Parganas Forest on October 26.

The problem of straying has come down by laying nylon net along the vulnerable areas of interface of forest and human habitation. Between 2007 and 2010, seven tigers were radio collared.

In some cases, radio collars slipped off the neck, indicating that tigers in the islands were smaller and weigh less than those in north and central India and have a higher level of adaptation. The satellite-based radio collaring, some of which have GPS attached, gave the locations of the tigers.

This exercise was carried out to ascertain whether the tigers in the Sundarbans are territorial.

Interestingly, a tiger captured in May 2010, which was released near Katuajuri camp near the Bangladesh border, crossed the mighty Raimangal river and remained on Talpatti Island of Bangladesh for a long time, as its activities were studied by researchers.

A trans-border habitat

This phenomenon highlights the Sundarbans as a habitat requiring a Trans-Border Protected Area involving India and Bangladesh.

The Sundarbans is the only mangrove forest in the world to be home to tigers, but the sea level rise is posing a threat to their survival. Pranav Chanchani, national coordinator for tiger conservation, WWF-India, said, "Certain studies have predicted that a 28 cm rise in the sea level (which is possible in the next 50-90 years) could result in more than 90% loss of mangrove habitats in this landscape, and catastrophic declines in the area's tiger populations."

IIT Guwahati uses superhydrophobic cotton to remove oil-spill

Removing up to 95% of oil-spill of different densities —

light and heavy oils — repetitively at least 100 times using superhydrophobic (extremely water repelling) medical cotton has been demonstrated by a team of researchers led by Dr.Uttam Manna from the Department of Chemistry at the Indian Institute of Technology (IIT) Guwahati.

The researchers turned the medical cotton, which is extremely water absorbing, into a superhydrophobic (water contact angle of 157 degrees) material and used it for absorbing oil both in air and under water. The efficiency of absorption is very high — above 2,000 weight percentage for both heavy and light oils. This translates to one gram of the superhydrophobic cotton absorbing 20 grams of either heavy or light oils. The results were published in the Journal of Materials Chemistry A.

The absorbed oil can be recovered through physical compression. The superhydrophobicity remained intact even when the cotton was manually compressed up to 1,000 times and subjected to other physical manipulations.

"The other important characteristic is its ability to absorb oil from three complex phases — light oil that floats in the air–water interface, sediment oil that settles at the bottom as it is heavy, and from water-in-oil emulsion," says Dr. Manna. The superhydrophobic property was intact even when exposed to UV light for ten days, the material was able to absorb oil from river and sea water, and extremely acidic (pH 1) and alkaline (pH 12) water.

Treating emulsions

While the cotton is able to efficiently absorb oil from water-in-oil emulsion, it is inherently incapable of removing oil from oil-in-water emulsion. In the case of water-in-oil emulsion, very little of water is present in oil and so it is easy to remove all the oil leaving the water behind. But in the case of oil-in-water emulsion there is very little of oil present. "Since there is more water present, the superhydrophobic material does not come in contact with oil and so will be unable to remove oil efficiently from oil-in-water emulsion," clarifies AdilMajeed Rather from the Department of Chemistry at IIT Guwahati and the first author of the paper.

Filtering oil

The researchers were able to achieve selective filtration of oil under water against gravity in the case of heavy oil that has settled at the bottom. To do this, the researchers plugged one end of a tube with the superhydrophobic cotton and dipped the tube so it comes in contact with the oil.

"Once in contact with the sediment oil, the cotton absorbs the oil and due to hydraulic pressure the oil gets removed from the cotton and accumulates inside the tube," says Dr. Manna. "So there is no need to apply pressure to collect the sediment oil from cotton."

In the case of gravity-driven filtration, heavy oil mixed with water is poured into a funnel, the tip of which is closed with the superhydrophobic cotton. The heavy oil settles to the bottom and comes in contact with the cotton which filters it leaving the water in the funnel. "This method can be used in industry to remove the oil component from water before letting out the waste water," says rather.

Cotton processing

The hydroxyl group seen in cotton is first modified with branched poly(ethylenimine (BPEI) to make it functionalised with amine group. A nanocomplex is prepared separately by mixing BPEI with dipentaerythritolpentaacrylate (5Acl) and added to the functionalised cotton. The nanocomplex provides essential topography and makes the cotton chemically reactive, thus making it possible to further optimise the appropriate chemistry of the material. The nanocomplex reacts with amine-based small molecules of choice to make the cotton hydrophobic to varying degrees.

"We can tune the hydrophobicity — from hydrophilic to superhydrophobic — by using different amine-containing small molecules," Dr. Manna says. "It is a green synthesis without the use of any catalyst or hazardous material. The process of making superhydrophobic cotton is a simple three-step process and scalable."

A flight of fancy to Indonesia's Raja Ampat Islands

Raja Ampat, the archipelago of more than 1,500 jungle-covered islands located in Indonesia's West Papua province is bound to figure on any diver's wish list. The waters around them teem with marine life, from the small critters that macrophotographers love to big fish like sharks and giant trevallies.

The only way to reach Waigeo Island is via the daily ferries from Sorong. Groups of four or more people can also consider renting a boat.

Few know of the rich bird and animal life above ground. Even fewer know about the Wilson's bird of paradise, a richly hued bird only found in the rainforests of the islands of Waigeo and Batanta in Raja Ampat.

For many years, scientists completely missed an important aspect of the complex mating dance of the brightly hued Wilson's bird of paradise. It displays a breast shield that looks like a vibrant green disc when seen from the point of view of the female perched just above it, on a branch. The bird recently starred in David Attenborough's

'Planet Earth II' series for the BBC.
Among birdwatchers, though, the Wilson's bird of paradise is legendary. The small and colourful male birds put up an amazing courtship display to impress the rather dull, brown females. Besides dancing, they display a stunning green breast shield that I was lucky to capture on camera.

For many years, scientists completely missed an important aspect of the complex mating dance of the brightly hued Wilson's bird of paradise. It displays a breast shield that looks like a vibrant green disc when seen from the point of view of the female perched just above it, on a branch. The bird recently starred in David Attenborough's 'Planet Earth II' series for the BBC.
As the biggest island in the Raja Ampat chain, Waigeo has a large variety of birdlife. This includes parrots, cockatoos and kingfishers. I stayed on the island for five days, at a home-stay in the small village near the coast. The rest of the land mass is covered in thick forest.

Taking a short nap in the middle of the stake-out at the 'lek' of the Wilson's birds of paradise to photograph the mating dance.
During those five days, I hiked into the forest daily and set up my equipment in a hideout near the lek—the place where the Wilson's birds of paradise come for their mating dance. It takes place close to the ground, making it quite a challenge to capture. After this, filming the mating dance of the red bird of paradise, which takes place in tree canopies, was much simpler.

Raja Ampat's beautiful coral formations and large schools of fish are best seen from liveaboard cruises on which travellers stay for several days, and which allow divers to travel much further than they could on a day trip from one of the archipelago's few resorts.
Though both birds are stunning, the one that posed the harder challenge always lingers in memory.

A black-capped lory kept as a pet in one of the village homes on Waigeo Island

The female Wilson's birds of paradise are dull brown creatures. But the males do a lot to impress them; including sweeping the ground clear of debris and fallen leaves before performing the mating dance.

The common spotted cuscus is a marsupial found only in Indonesia, Papua New Guinea and Australia. The size of a small cat, it is a shy nocturnal animal that spends its time almost entirely among the treetops. Photographs by Dhritiman Mukherjee
Wildlife and nature photographer Dhritiman Mukherjee, whose work has been showcased by, among others, the BBC, National Geographic, The New York Times and Unesco, spends more time in forests and oceans around the world than his home in Kolkata.

Elephant corridors in India threatened, says study

Elephant herds are known to migrate across 350-500 sq. km. annually but increasingly fragmented landscapes are driving the giant mammals more frequently into human-dominated areas, giving rise to more man-animal conflicts, experts have found. Maintaining elephant corridors is therefore of crucial importance to both elephant and human habitats.
"Elephant corridors are narrow strips of land that connect two large habitats," says Dr. Raman Sukumar, scientist, Indian Institute of Science, Bengaluru. "In many cases, they are already under the control of a government agency such as the Forest or Revenue Department. Corridors could include unutilised spaces in large commercial estates, and fallow or agricultural lands."
'Right of Passage', an 800-page study released in August 2017, authored by experts and published by the Wildlife Trust of India (WTI) in collaboration with Project Elephant and the U.K.-based NGO Elephant Family, identifies and records details pertaining to 101 elephant corridors across India.
Of these 101 corridors, 28 are located in south India, 25 in central India, 23 in north-eastern India, 14 in northern West Bengal and 11 in north-western India.
In terms of their functionality or usage by elephants, almost 70% of the 101 corridors are regularly used, 25% are occasionally used, and 6% rarely. Almost all elephant corridors in south India (93%) and northern West Bengal (86%) are regularly used; 66% of corridors are regularly used in northeastern India.
The study offers specific conservation solutions for the corridors but points to an inverse relationship between the forest cover available and the number of corridors in each region — the more fragmented the forest cover in a region, the more elephant corridors in it.
Thus, the highest numbers of corridors are located in northern West Bengal, which has one corridor for every 150 sq. km. of available elephant habitat, resulting in heightened human animal conflict and an average of 48-

50 human deaths every year. This is followed by north-western India, which has one corridor for every 500 sq. km. of available elephant habitat. Central India comes next with one corridor for every 840 sq. km.

In southern India, there is one corridor for every 1,410 sq. km. of available elephant habitat. Northeastern India fares best with one corridor for every 1,565 sq. km.

Among the States, West Bengal has the highest number of corridors (14), followed by Tamil Nadu with 13 and Uttarakhand with 11.

In 2005, WTI had mapped and listed 88 elephant corridors. With alterations to natural landscapes and a heightened pace of development, researchers found that seven of these corridors have been impaired and are currently not used by elephants. The team also added 20 new corridors to the list, bringing the total to 101 corridors in the 2017 'Right of Passage' study.

The then-and-now comparative findings are worrying. The 2017 report notes that about 74% corridors are of a width of one kilometre or less today, compared with 45.5% in 2005, and only 22% corridors are of a width of one to three kilometres now, compared with 41% in 2005, pointing to how constricted corridors have become in past 12 years.

The ground situation studied in 2005 and 2017 also indicates degradation of corridors: 21.8% of corridors are free of human settlements in 2017 compared with 22.8% in 2005, and 45.5% have 1-3 settlements in 2017 compared with 42% in 2005. In terms of land use, only 12.9% of the corridors are totally under forest cover in 2017 compared with 24% in 2005.

"About eight corridors have been secured on the ground by State Forest Departments, MoEFCC (Ministry of Environment, Forest and Climate Change), WTI, and other conservation organisations. This process needs to be hastened and other high priority as well as threatened corridors need to be secured on an urgent basis," says co-author Dr. Sandeep Kr Tiwari, Programme Manager, IUCN Asian Elephant Specialist Group (AsESG).

To increase awareness on elephant corridors, the team is planning 'GajYatras' — parading life-size elephant models crafted by local artisans on road shows through corridors across 12 States where elephants range.

Disrupted areas

Moreover, two in every three elephant corridors in the country are now affected by agricultural activities, the study points out, adding that 58.4% corridors fall under settled cultivation and 10.9% under jhum (slash and burn) cultivation.

"All the corridors in northern West Bengal (100%) and almost all in central India (96%) and northeastern India (52.2% under settled cultivation and 43.4% under slash and burn cultivation) have agriculture land. About 72.7% of the corridors in northwestern India and 32% corridors in southern India have agriculture land," the study states.

Taking note of 266 instances of elephant's deaths caused by being run over by trains between 1987 and July 2017, the report points out that 20 corridors have a railway line passing through them.

In all, about 36.4% of the elephant corridors in northwestern India, 32% in central India, 35.7% in northern West Bengal and 13% of the elephant corridors in northeastern India have a railway line passing through them. Moreover, almost two-thirds of the corridors have a National or State Highway passing through them, fragmenting habitats and hindering elephant movement further.

The study notes that almost 20% of the corridors urgently require an overpass for vehicles to facilitate the unhindered movement of elephants. In addition to railway tracks and highways, 11% of corridors have canals passing through them, and 12% are affected by mining and the extraction of boulders.

Three months ago, the Supreme Court, in response to a Public Interest Litigation (PIL) petition submitted by Wildlife Conservation Society-India (WCS) scientist VidyaAthreya suggested that nine States acquire land across 27 high-priority corridors to enable safe movement of elephants.

"Identifying corridors is a dynamic process; many States have started notifying corridors," says R.K. Srivastava, Director of Project Elephant. The States' responses are expected this month.

"Large-scale land acquisition is not required," says Professor Sukumar. "It is the small, strategic pieces of land that are crucial."

The International Fund for Animal Welfare and the WTI bought 25.5 acres of village land in 2003 and handed over India's first ever privately-bought corridor to the Karnataka government in 2007. The WTI and its partners have also secured six corridors, including the Edayaralli-Doddasampige corridor in southern Karnataka, which connects the BiligiriRangaswamy Temple and MM Hills wildlife sanctuaries. "The way corridors are acquired is important," says Professor Sukumar. "Approaches have often been antagonistic to local people — this really needs to change. Land acquisition has to be a voluntary and rewarding process."

'Eviction not the answer'

"It is important to involve communities in conservation," concursParameshaMallegowda, Programme Associate at the Bengaluru-based Ashoka Trust for Research in Ecology and the Environment. "Eviction is definitely not the answer. Rather than relocating entire villages, we need to restore the corridors and ask people to avoid using critical [elephant] migratory routes. Conservation is an achievement only if local communities are also involved in the process."

As Dr. Tiwari notes, "At a time when about 400 to 450 humans are losing their lives due to human-elephant conflict annually in India and around 100 elephants are being killed in retaliation, it is high time that the migratory corridors that elephants have traditionally used are saved before it is too late."

Bamboo ceases to be a tree, freed of Forest Act

After 90 years, the bamboo has legally ceased to be a tree with the government, , amending the Indian Forest Act and axing the bamboo — taxonomically a grass — from a list of plants that also included palms, skumps, brush-wood and canes.

In doing so, said Union Environment Minister Dr. Harsh Vardhan, the government hoped to promote cultivation of bamboo in non-forest areas to achieve the "twin objectives" of increasing the income of farmers and also increasing the green cover of the country. Bamboo grown in the forest areas would continue to be governed by the provisions of the Indian Forest Act.

'Required permits'

For several years now, the classification of the bambooas a tree meant that it couldn't be easily ferried across State borders. It also required permits from village councils and couldn't be cultivated in non-forest areas.

"This will now create a viable option for cultivation in 12.6 million hectares of cultivable waste land. It will encourage farmers and other individuals to take up plantation/block plantation of suitable bamboo species on degraded land, in addition to plantation on agricultural land and other private lands under the agro-forestry mission," the Minister added in a press statement.

Experts hail move

The amendment was cleared as an ordinance and is therefore yet to get parliamentary backing. However experts welcomed it saying that it removed ambiguity on the status of bamboo and also brought it in harmony with the related Forest Rights Act. "Tribals have a right to forest produce but its earlier classification posed problems," said environmental lawyer, RitwickDatta.

The current demand of bamboo in India is estimated at 28 million tonnes. Though the country has 19% share of the world's area under bamboo cultivation, its market share in the sector is only 6%. At present, it imports timber and allied products, such as pulp, paper, and furniture. The amendment will help in addressing some of these issues, besides meeting the demand from domestic production, the press note added.

BS-VI fuel in Delhi from 2018

In a bid to deal with the critical pollution situation in the national capital, the Ministry of Petroleum has brought forward the date for the rollout of BS-VI fuel for Delhi to April 1, 2018 instead of the original deadline of April 1, 2020.

The Ministry said in a statement that the decision to advance the launch, prompted by "the serious pollution levels in Delhi and adjoining areas," was taken in consultation with the Public Oil Marketing Companies.

OMCs have also been asked to examine the possibility of BS-VI auto fuel introduction in the whole of the National Capital Region (NCR) area with effect from April 1, 2019.

The auto manufacturing umbrella body, the Society of Indian Automobile Manufacturers (SIAM), has said that while the switch to the BS-VI fuel in Delhi can reduce the particulate emissions from the existing fleet of vehicles, there are more steps the government can take, such as stringently enforcing the order banning BS-II and earlier vintage vehicles from plying in the NCR.

Delay in the protection of corridors threatens tiger population

It is not just poaching or habitat loss that threatens India's tiger population. Delayed action to protect crucial wildlife corridors — despite the availability of relevant ecological knowledge — is also killing these big cats, shows a study published in conservation journal Oryx.

For species like tigers which move across large distances, wildlife corridors, protected patches of land connecting two habitats, are crucial. Uttarakhand'sChilla–Motichur corridor is one such patch connecting the eastern and western tracts of the Rajaji Tiger Reserve. It is the only way tigers from the eastern tract (part of a larger, more connected landscape) can colonise the isolated western one. Over the years, however, the corridor has been deteriorating due to reasons including the expansion of nearby townships and the construction of a na-

tional highway and rail line.

Multi-pronged approach

Scientists at the Panthera, Nature Conservation Foundation and the University of Kent, U.K., used a multi-pronged approach to study the status of the Chilla–Motichurcorridor. First, they studied tiger presence in the area using presence–absence surveys of tiger signs, assessing change in tiger presence from data gathered between 2002 and 2009. While the eastern tract showed a high presence of tigers, the western one showed a distinct decline in tiger numbers and presence.

Second, the team studied the corridor's connectivity using remotely-sensed night-time lighting as an indicator of urbanisation.

They found that since 1993, urbanisation had decreased opportunities to restore the effectiveness of the corridor considerably.

The team compiled 31 research articles on the corridor and made 14 distinct recommendations to restore corridor connectivity. Only five recommendations have been incorporated into government management plans, and delays in mobilising funds and approvals from state departments followed by the lack of deadlines to implement these actions exacerbated the problems.

"Institutional failings are mirrored in the inability of many state and central departments to work together for the restoration of Chilla-Motichur; this case typifies what happens with most wildlife corridors across the country," says lead author AbishekHarihar (Panthera and Nature Conservation Foundation). "If immediate action is not taken, the population in the western tract could go extinct."

Govt. working on new 'gas standards'

The government is looking to prepare a unified testing methodology to ensure that all agencies that map air pollution use accurate instruments.

The Council of Scientific and Industrial Research (CSIR)-National Physical Laboratory (NPL) is in the process of setting up 'gas standards', or reference samples of Carbon Monoxide (CO), Sulphur Dioxide (SO2), Nitrous Oxide (NO2) and Particulate –Pb (lead), –As (Arsenic) and –Ni (Nickel).

Currently, the National Ambient Air Quality standards specify the upper limits for pollutants and, based on this, the Air Quality Index — that grades air quality in cities from 'Good' to 'Severe' — is prepared for several Indian cities.

Devices not calibrated

"However we have noticed several times that these measurement devices are not calibrated and errors creep in," said D.K. Aswal, Director, and National Physical Laboratory. "This month, we are ready with the standards for several pollutants."

Going ahead, he said, there would be talks with environment-monitoring agencies like the the Central Pollution Control Board (CPCB) to see if these can become reference standards for use by all private and public agencies that measure pollution levels.

CPCB has prescribed guidelines for the maximum permissible levels of 12 gases and pollutants, depending on residential, rural or industrial locations. Standards for PM2.5 were laid out in 2009, though CPCB is now mooting a proposal to revise these standards, a senior official in the organisation hadtoldThe Hindu earlier this year.

The NPL has also developed a custom air sampler that claims to measure PM2.5 levels far more accurately than existing devices.

India loses billions to air pollution: UN

India had the highest share of welfare costs (or a loss of income from labour), of about $220 billion (about Rs. 1.4 trillion), in South and South-East Asia — of a combined total of $380 billion from mortality due to air pollution, according to a report by the United Nations Environment Programme (UNEP).

The global mortality costs from outdoor air pollution are projected to rise to about $25 trillion by 2060 in the absence of more stringent measures. At regional and national scale, China's welfare costs from mortality were the highest at nearly $1 trillion followed by the Organisation for Economic Corporation and Development (OECD) countries with a combined total of $730 billion, the report added quoting a 2016 projection by the OECD.

Although certain forms of pollution have been reduced as "technologies and management strategies have advanced," approximately 19 million premature deaths are estimated to occur annually as a result of the way societies use natural resources and impact the environment to support production and consumption, it notes.

Serious burden

"If consumption and production patterns continue as they are, the linear economic model of 'take-make-dispose' will seriously burden an already-polluted planet, affecting current and future generations," the report's foreword concludes.

To curb pollution in various forms, the UNEP called for strong high-level political commitment and engagement of the local government, civil society and other stakeholders. "Pollution is a universal challenge [but] the good news is that we already know what we need to do to pre-

vent and reduce it," UNEP Executive Director Erik Solheim said in a statement, stressing that "now the responsibility is on governments, businesses, cities and local authorities, civil society and individuals around the world to commit to act to beat pollution in all its forms."

To achieve high level political commitment in key economic sectors, there is a need to go beyond the environmental ministries and include other relevant ministries such as finance, agriculture, industry, urban, transport, energy and health.

There is also a need to engage the local government, civil society organisations, business leaders, industries, trade unions and citizens at large. Reporting on the progress that comes from acting on pollution – whether through voluntary measures or formal laws – is a crucial step in this transition.

The report, 'Towards a pollution-free planet', was launched during the first Conference of Parties for the Minamata Convention, which addresses mercury issues, and ahead of the annual U.N. Environment Assembly, to be held in early December.

'Eco-cremation' with agri-waste bricks

It was during a cremation five years ago that Vijay Limaye wondered how many trees must have been 'killed' to ensure 'moksha' (salvation) for the departed soul. It was then that the concept of a 'green cremation' struck him and he began a venture that has won praise from various quarters, including Prime Minister Narendra Modi.

Speaking at an event in Delhi on August 22, Mr. Modi lauded the Nagpur-based entrepreneur for his efforts to protect the environment.

The Nagpur Municipal Corporation, in association with Limaye's NGO Eco Friendly Living Foundation, is planning to offer eco-friendly cremations at four crematoriums, the entrepreneur said.

"Cremation using agro-waste briquettes along with LPG crematoria will be introduced at these four places," he said.

"Taking into account sentiments and traditions where rituals like funeral pyre are needed, I began working on an alternative to wood," Mr. Limaye said. "Initially, dung cakes were promoted but after the number of people choosing the dung cake method increased, we were faced with a shortage of dung cakes."

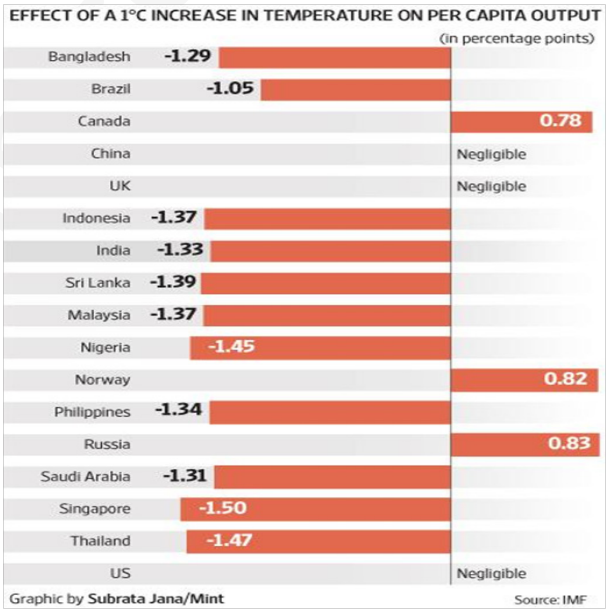
Mr. Limaye then began searching for an alternative to dung cakes and his team succeeded in making hard bricks with the right mixture of agro waste, named Mokshkastha, with which to cremate the dead.

India among the worst affected by climate change: IMF study

A study on the impact of climate change by the International Monetary Fund, or IMF, shows countries in the tropics will be the worst affected as a result of global warming.

"For the median emerging market economy, a 1°C increase from a temperature of 22°C lowers growth in the same year by 0.9 percentage point," says the report.

The accompanying chart shows the effect of a 1 degree rise in temperature on per capita output for several countries.



India is one of the worst affected, with its per capita output expected to fall by 1.33 percentage points.

Other countries in the region, such as Bangladesh, Pakistan, Sri Lanka, Indonesia, Malaysia will be similarly affected.

Note that the impact of most developed nations, located in the temperate zone, is negligible. The overall impact on China's growth, too, is estimated to be negligible. On the other hand, some northern nations such as Russia, Norway and Canada will see their growth improve.

These predictions underline the importance of policies to combat the impact of climate change in countries like India.

From noise to music: How the LIGO team heard the famous 'chirp'

With the 2017 Nobel Prize for physics going to the LIGO-VIRGO collaboration for having directly observed gravitational waves for the first time, black hole mergers have become a byword. The instrumentation to differentiate and detect this faint signal from the noise was a crucial contributions made by Nobel Laureate Rainer Weiss.

The first gravitational waves that were detected were small fluctuations of spacetime caused by a violent merging of two black holes about 1.3 billion light years away. We know that light bends due to a change in refractive index of the air near hot objects like a heated asphalt road. Light also bends when spacetime curves due to the presence of massive gravitational fields. When a gravitational wave is incident on the detector, the laser beam behaves in a similar manner. One main difference is the magnitude. The difference between bending of light in cool air and hot air is about 1%, whereas the bending caused by a gravitational wave is about one billion times smaller than the thickness of a human hair.

Sensing the minute

"That's pretty small. How can we turn something like this into a signal that's measurable to us?" asks Rana Adhikari, Professor of Physics at Caltech, who has been involved in the construction and design of the detectors since 1997. He explains, "From my PhD advisor, Rai Weiss, I got the strong impression that it was embarrassing to not understand in exacting detail all the constituents of the noise in the experiment. Once we went down the road of making the detailed study of noise a science in itself, we realized that there are no limits to measurement. Everything that we wish to understand about the universe can be revealed by careful design of experimental apparatus."

The photodetectors are sensitive to the brightness of the incoming signal. When there is no signal, the two arms of the LIGO detector are arranged so that there is cancellation of contribution of light. There is still some small amount of light coming through. When there is a signal, this light shows a variation. "We measure how much light is seen when it is very dark [that is, there is no signal]. This is about the same as a small handheld laser pointer. On top of that brightness, we are trying to measure a variation in brightness level of about one part in one billion. This is manageable. This is just what can be done with the best electronics that we have today," he says.

Ground vibrations

The electronics converts photons into electrons. Like in the human ear, there is an electrical signal which has to be turned into sound. The detection is in the range of frequencies from about 20 Hz to 10 kHz. "The challenge is how to reduce the vibration from the ground at those frequencies," Prof Adhikari says.

"[The relevant] ground vibrations are about 1% of the diameter of the hydrogen atom, or one hundred million times larger than we can handle. We need this vibration to be reduced by a factor of one hundred million. We do this by using many, many springs" The arrangement is that of some six layers of heavy metal beds connected by strong springs. At every layer the vibrations of the ground are cut off by a significant factor.

LIGO's interferometers are a ten orders of magnitude improved as compared to the first interferometer made by Albert Michaelson in 1881, which was able to measure a displacement in nanometres.

Under the high degree of vacuum needed, stainless steel has the problem that the hydrogen separates out. So a special stainless steel called low-hydrogen stainless steel was needed. The steel tubes are also used to house the lasers and have to be very clean. These are being made at Institute for Plasma Research in Ahmedabad.

In all, the tubes measure 8 km in length and have a diameter of 1.2 m. "So it's quite a large empty space, and it's all one piece. No one had made such a large vacuum chamber earlier, so this is the largest empty space in the world," Prof. Adhikari smiles.

16 balsam species found in 5 years in Arunachal

In August 2017, a research paper describingImpatienswalongensis, a new species of balsam, was published in the peer-reviewed scientific journalPhytotaxa .

The species was discovered from Arunachal Pradesh's Anjaw district, one of India's easternmost. About a meter tall with ovate elliptical leaves and light pink flowers, the plant was named after Walong, the locality where it was found.Impatienswalongensisis the latest but not the only new discovery of balsam in Arunachal Pradesh.

In 2017 alone, scientists discovered and published their findings on five other new species of balsam, taking the total number of balsam species discovered this year to six.

Impatiens arunachalensis, which bears purple flowers and a pink throat, was discovered from the Upper Siang district. Since only 50 plants of the species were found at a particular location, scientists described the conservation status of the plant as critically endangered.

Another species,Impatienszironiana, with lanceolate pale yellow floral buds flowering and fruiting in the rainy season from July to September, was discovered from the Lower Subansiri district.

Two more species of balsam, Impatiensrugosipetalafrom the State's Lower Dibang valley, andImpatienstatoensisfrom the West Siang district, were also discovered and described earlier this year.

"Three new species of balsam were discovered from Arunachal Pradesh in 2016, and five [were discovered] in 2015. Since 2013, at least 16 new species of plants under the genus Impatiens, commonly referred to as balsam, have been discovered from Arunachal Pradesh," said RajibGogoi, a scientist with the Botanical Survey of India (BSI), who has been working on balsams in Arunachal Pradesh since 2012, told The Hindu .

He said that botanists have found 55 species of balsam from the northeastern State, 16 of which are new discoveries to science.

Soil requirement

Known for their starkly differing flower shapes, which are produced along the stem with vivid colours like pink, red, white, purple and yellow, balsams grow in rich moist soil. Across the world, about 1,000 species of these angiosperms or closed seeded plants are known to occur.

In India, about 210 balsam species were known till these new discoveries from Arunachal Pradesh emerged. Now, the number of balsam species has increased to 230.

"What makes the Impatiens interesting is the high endemism among these plants. In most cases, while collecting the specimens, only a handful of plants are spotted. Since these plants have a very small habitat, they face a threat from the fast-changing landscape of the region," said Souravjyoti Borah, another botanist associated with these discoveries.

Mr. Borah, who has been working with Mr. Gogoi on genus Impatiens, pointed out that inaccessibility and the difficult terrain of the region were among the reasons why it took so long for the new species to be discovered.

The researchers also had to dissect and study their morphology in the field itself.

Boosting horticulture through remote sensing

Union Agriculture Minister Radha Mohan Singh announced March 2018 as the deadline to complete the ambitious project of developing the horticulture sector using remote sensing technology and geo-informatics.

India is the second-largest producer of fruits and vegetables in the world and the biggest producer of fruits such as banana, mango, papaya and lemon among others. But the country still has some distance to cover in terms of exports as post-harvest wastage of produce in India is high.

In 2015, the Modi government started project CHAMAN — acronym for Coordinated Horticulture Assessment and Management using geo-informatics — to prepare a comprehensive horticultural plan. Using remote sensing technology to study soil conditions, land use, weather and cropping patter, the Centre has chosen 185 districts across the country where seven selected crops are being promoted.

Once complete, the findings of the project would be shared with all states to give to boost to cultivation of horticultural crops.

States put into groups

Different states have been divided into different groups to grow banana, mango, citrus fruits, potato, tomato, onion and chilli.

Sharing the progress of the project CHAMAN at a press briefing, Mr Singh said the Centre would convene a meeting of the northeastern states by January next year as the report on horticulture development for this region was ready.

"This sector provides nutrient rich crops to the people and better remunerative prices to the farmers and increases their incomes," Mr. Singh said.

Under CHAMAN, Tamil Nadu, Andhra Pradesh, Karnataka, Gujarat and Maharashtra have been identified as the major banana-growing states. Mango cultivation is being promoted in Andhra, Bihar, Uttar Pradesh, Karnataka and Telangana, while onion is the focus for Maharashtra, Gujarat, Karnataka and Madhya Pradesh.

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HEALTH AND MEDICINE

IIT Roorkee repurposes a drug for chikungunya

Adrug to treat chikungunya virus infection is in the offing, and in vitro studies carried out by a team of researchers from the Indian Institute of Technology (IIT) Roorkee show promise. Currently, there is no cure for the disease and treatment is focused more on relieving the symptoms.

Since the team led by Prof. ShaillyTomar from the Department of Biotechnology at IIT Roorkee used an existing drug piperazine, safety of the drug is already known and hence the trials on animals and humans will be more to understand the efficacy of the drug in treating chikungunya infection.

Piperazine is used for the treatment of worm infections. The antiviral drug indinavir used for treating HIV positive people is a piperazine-based molecule. The derivatives of piperazine are used as anti-histamines and anti-depressants drugs too.

Based on crystal structure, the researchers ascertained that the drug molecule binds to the hydrophobic pocket of capsid protein of Aura virus. Drug binding studies were also carried out using chikungunya virus and it was found that the binding of the drug at the caspid protein was better in the case of chikungunya virus. The function of capsid protein is essential for the virus budding and replication of virus.

On studying the antiviral activity of piperazine molecule against chikungunya, it was found that the molecule inhibits virus replication. “In the presence of this drug, the amount of virus released by infected cells is less. The drug showed very good antiviral activity,” says Prof. Tomar. The results were published in the journal Antiviral Research .

Chikungunya viral load reduces significantly when treated with 3 millimolar (mM) of piperazine and has “barely detectable cell teoxicity” when the dosage is doubled to 6mM. “Compared with controls, the inhibition of the virus replication was nearly 98% when 6mM of the drug was used,” Prof. Tomar says.

The researchers were not able to directly observe a reduction in the budding process. “We observed a reduction in the virus release from infected cells and we hypothesise that the drug inhibits the budding of the virus as well,” she says. Once the drug binds to the target, the capsid protein’s interaction with the enveloped protein of virus is inhibited and hence the virus release from infected cells is affected.

Virus replication and budding are correlated. The monkey cell lines were infected with very low virus concentration and then allowed to grow. After 24 hours, the number of virus being released by the infected cells was studied. If the virus is able to replicate then should find more virus, which was not the case.

The chikungunya viral load had reduced by 98% at the end of 24 hours but increases at 48 hours indicating that inhibition of virus replication becomes less at the end of 48 hours compared with 24 hours. “This could be because the drug does not kill all the virus at the end of 24 hours and the drug supplied initially is already bound to the capsid protein target in the virus. So when the virus reinfects nearby cells and replicates, there is not enough drug to bind to the new capsid protein molecules being produced,” Prof. Tomar explains.

“The drug molecule is not toxic to normal cells even when 6mM was used,” says Ramanjit Kaur from the Department of Biotechnology at

IIT Roorkee and one of the first authors of the paper.

"We are in the process of developing new piperazine-based drug molecules," says Megha Aggarwal from the Department of Biotechnology at IIT Roorkee and the other first author of the paper.

The researchers are planning to carry out trials on animals. Since the drug is already approved for use in humans, toxicity studies in animals will not be needed. But studies on animals to evaluate the antiviral activity and, hence, the efficacy has to be carried out. "If results from animal trials are encouraging then we might start human clinical trial," Prof. Tomar says.

Elevated enzyme for cancer diagnosis

Researchers at the Indian Institute of Technology (IIT) Ropar, Punjab, and IIT Mandi, Himachal Pradesh, have utilised the overexpression of biotin receptors on cancer cells and enhanced production of thioredoxin reductase (TrxR) enzyme in cancer cells for cancer diagnosis. Breast and cervical cancer cell line studies showed encouraging results.

The researchers developed a hybrid assembly by binding naphthalimide moiety to carbon dots using disulphide covalent bond; naphthalimide analogues are used as anticancer agents. In the presence of normal amount of TrxR enzyme seen inside normal cells, the carbon dots behave as an energy donor and the naphthalimide moiety as an acceptor, thus establishing fluorescence resonance energy transfer (FRET). There is a typical yellow emission when irradiated with visible light.

But in the presence of elevated levels of TrxR enzyme, which is seen in cancer cells, the disulphide covalent bond gets disrupted freeing the naphthalimide moiety from the surface of carbon dots. As a result, the FRET gets disrupted and there is blue emission when the cells are irradiated with visible light. In normal cells, the amount of TrxR enzyme is very little and hence the FRET mechanism is not eliminated, resulting in yellow emission.

"We can distinguish cancer cells from normal cells by the colour of the emission. The presence of yellow emission indicates normal cells while blue indicates cancer cells," says Dr. Narinder Singh from the Department of Chemistry at IIT Ropar and the corresponding author of the paper published in the journal ACS Applied Materials & Interfaces.

Unlike normal cells, cancer cells have large number of biotin receptors. Since biotin is present on the surface of carbon dots, the hybrid assembly is absorbed in large numbers by cancer cells.

"Within 30-45 minutes of treatment, we could see the change in emission from yellow to blue. The blue emission could be seen up to two hours after its appearance," says Dr. Singh.

"When the bond is intact the emission comes from the naphthalimide moiety, and when the bond is broken, the emission comes from the carbon dots," says Jagpreet Singh Sidhu from the Department of Chemistry at IIT Ropar and the first author of the paper. "The band gap between carbon dots and naphthalimide moiety is different leading to different emissions."

"Since visible light cannot penetrate human tissue, the potential application of this technique may be during surgery to know tumour spread. We will know more about its applicability only during animal studies," he says.

Therapeutic

The naphthalimide used here can also function as a cancer therapeutic. The nanosensor was found to reduce the viability of cancer cells up to 70%. The naphthalimide that gets released when the disulfide bond is broken is responsi-

ble for the destruction of cancer cells. "We had used higher concentration (100 microgram per millilitre) of naphthalimide to kill 70% of cancer cells. Usually, much lower concentration of drug is used for therapeutic purposes," says Ashutosh Singh from the School of Basic Sciences at IIT Mandi and one of the authors of the paper. Since naphthalimide is expensive, the researchers are trying to develop a cheaper substitute. "We will test the new hybrid material on more cancer cell lines before testing it on animal models. The focus is on using the assembly for diagnostics. If it offers therapeutic benefits then it will be an added advantage," says Dr. Singh.

Magic mushrooms may reset depressed brains

A psychoactive compound occurring naturally in "magic mushrooms" may help reduce symptoms of depression as well as "reset" brain activity in affected patients, a study has shown.

The findings demonstrated that Psilocybin mushrooms, also known as psychedelic mushrooms, effectively reset the activity of key brain circuits known to play a role in depression.

"We have shown for the first time clear changes in brain activity in depressed people treated with psilocybin after failing to respond to conventional treatments," said Robin Carhart-Harris, Head of Psychedelic Research at Imperial College London.

"Several of our patients described feeling 'reset' after the treatment. Psilocybin may be giving these individuals the temporary kick start they need to break out of their depressive states and these imaging results do tentatively support a reset analogy," Carhart-Harris added.

For the study, published in the journal Scientific Reports, the team examined patients with treatment-resistant form of the disorder with two doses of psilocybin (10 mg and 25 mg).

Following the treatment, patients reported a decrease in depressive symptoms, corresponding with improvements in mood and stress relief.

IISc: new tool to diagnose malaria

By studying the properties of normal red blood cells (RBCs) and parasite-infected RBCs, scientists at the Indian Institute of Science, Bengaluru, (IISc) have developed a new diagnostic tool for early detection of malaria.

Currently, visual microscopic identification of the malarial parasite Plasmodiuminside red blood cells (RBCs) is used, but the new tool can detect the disease even in RBCs that do not themselves host the parasite but lie near the infected ones. RBCs that lie close to the infected ones appear rigid much like the affected ones and this helps in easy diagnosis. The results were recently published inBiomedical Journal.

Optical-tweezers

Blood samples with malaria infections caused by P. falciparum and P. vivax were collected from the Bangalore Medical College and Research Institute and studied. RBCs were separated out from the blood, and a single RBC was trapped in an optical tweezer trap. In this technique, laser beams are focused at the micron-sized RBC (like tweezers holding the RBC) under a microscope and imaged with a video camera.

The Brownian motion (random movement of particles) of the normal RBC was found to be different from the infected ones.

A photodetector was used to measure this motion of the trapped particle. The researchers quantified the fluctuations using the 'corner frequency' measurement. The corner frequency of normal cells was 25 hertz whereas it was 29 hertz for infected cells. The change in frequency was due to the difference in the rigidity of the cells; the infected cells were more rigid compared to the normal ones.

When trapped, the RBC gets folded as it is bi-concave in shape and the time taken for folding inside the trap was measured. As the infected cells were more rigid they took about 1.33 seconds to fold whereas normal cells took only 0.8 seconds. A measure of folding time can also be used to determine whether a cell is infected.

Bystander effect

"Only 2-5% of the RBCs host the parasite. But we can see the rigidity in other RBCs in the infected pool also. This is called the bystander effect and it is very helpful in our tweezers study. P.vivax infects mainly the immature RBCs (reticulocytes) but due to this effect we could see changes in the mature RBCs not hosting the parasite too. We are yet to understand what exactly is released into the blood stream that causes rigidity even in the non-hosting cells," says Apurba Paul from the Department of Physics at IISc and first author of the paper.

According to the researchers, the tweezers technique can be used as a general screening tool for all stages of malarial infection. "The technique is very easy and does not require trained personnel as it is fully automated. Very little blood is needed, and it can be drawn at any time of the day. The changes can be seen in the blood even when the parasite count is very low due to the bystander effect," Paul adds.

Phone App for cancer study

A new smartphone App, SmartIHC-Analyser, developed by researchers at the Indian Institute of Technology (IIT) Kharagpur can now help in faster and more accurate evaluation of cancer after treatment. The App analyses the expression of a protein marker (Ki-67) for determining an increase in cancer cells. The App, now available for Android phones, analyses microscopic images of stained cancer tissue and in less than a minute tells if there is progression or regression of cancer cells post treatment.

The smart phone is fitted to the eye-piece of the microscope using a specially designed 3D-printed holder to take microscopic images of the cancer cells. To analyse proliferation, the colour variations in the stained cancer cells are studied. Cells positive for the protein marker will appear brown whereas the negative ones will appear blue.

In the manual method, pathologists observe these colours using the naked eye and count the cells. This method is time-consuming and technician-dependent. The new App takes pictures and counts the differently stained cells and gives the proliferation index in less than a minute.

"The proliferation index tells us the rate at which the cells are dividing or how fast the tumour is growing during the progress of cancer and helps in deciding future therapy. In manual counting, pathologists observe only two to four different areas of the tissue and give a mean score. The new automated quantification is repeatable and we can take many pictures in different areas of the tissue slide for a robust mean value," explains Suman Tewary from the School of Medical Science & Technology at IIT Kharagpur and the first author of the paper published in the journal Analytical Methods.

Comparative analysis

The researchers analysed 30 cases of Ki-67-stained breast cancer tissues collected from Tata Medical Center, Kolkata (which collaborated in the study) and compared the results from the App with manual counting. Compared with manual method, the App had nearly 97% accuracy.

The researchers also compared it with a benchmark web-based application ImmunoRatio. The average difference between manual scoring

and new App was only 6%, whereas it was 15% for ImmunoRatio.

"The application of immunohistochemical (study of specific proteins in cells) analysis helps in identifying the degree of severity and in understanding the effects of the given treatment. Health workers at public health centres can be trained to use the App thus enabling faster results," says Prof. Chandan Chakraborty of School of Medical Science & Technology at IIT Kharagpur and corresponding author of the paper.

Can gene drive wipe out all mosquitoes?

In scientific research, periodically, blockbuster applications with the potential to prevent and cure diseases of mankind as never before take the community by storm. Gene therapy, stem cell therapy and synthetic biology are some such examples. Although, backed by strong scientific evidence, applications get entangled with too many technical, ethical and environmental issues to even realise modest success.

Gene drive technology to wipe out insects and pests is the latest addition in this category. It can potentially eliminate mosquitoes that cause malaria, dengue, Zika, chikungunya, yellow fever, West Nile, sleeping sickness, Lyme and others. It also has potential to eliminate pests infecting crops in agriculture. Elimination of the mosquito vector, starting with the malaria vector, has more than topical interest in India with Tata Trusts donating $70 million (Rs 458 crore) over the next 5 years in setting up The Tata Institute of Genetics and Society at the University of California San Diego in the US (UCSD) and mentoring its branch at the Institute for Stem Cell Biology and Regenerative Medicine (InStem) in Bengaluru. Half the grant is said to be for use in India for research and training of scientists at UCSD.

The idea itself is not new. Barbara McClintock got the Nobel Prize for discovering the jumping genes in maize. Transposons or jumping genes are DNA elements that move from one location to another in the genome. The P element discovered in Drosophila, apparently not present before the 1950s, has now spread to all fruit flies. Propagation of a genetic modification to block sexual reproduction in mosquitoes can eliminate this pest. In gene drives, the inheritance bias for an altered gene can be pushed to 100% unlike the 50% inheritance seen in Mendelian division. In 10 generations, the gene drive can increase the frequency by a relative 1,024-fold. The idea was born at the Imperial college, London, based on the homing endonucleases of yeasts and algae. The endonuclease gene gets inserted into the target DNA sequence that will prevent further cleavage, but the enzyme will cut the homologous chromosome that does not contain the endonuclease gene. The endonuclease gene containing chromosome will now act as a template giving rise to a replica, thus facilitating 100% inheritance of this gene. This concept has received a fillip with the availability of precise gene editing mechanism using CRISPR-Cas9 system. Imperial college and other groups including those at the University of California (UCSD); Wyss Institute, Harvard University; Broad Institute, MIT are all in the fray, extending the studies to Anopheles gambiae (African malaria vector) and Anopheles stephensi (major vector in India).

Rapid expansion of the mutated gene introduced into the germ line has been shown in caged mosquito populations. Will it work in the wild? The idea is to release such altered populations in sufficient numbers even periodically so that they can mate with the wild types and render the entire population vulnerable.

The biggest challenge is to prevent emergence of resistance over a period of time to the nuclease. Interference with fertility genes to prevent reproduction may actually impose a large selection pressure for resistance development in the mosquito. This has turned out to be true in a recent experimental study, where after an initial increase in gene drive, nuclease-resistant mutants started to emerge. Alternate strategies to target the receptor for the parasite in the mosquito (yet to be discovered) or a gene drive carrying an antimalarial peptide/single chain antibody to kill the parasite are contemplated. At UCSD, researchers have successfully followed the latter strategy in A. stephensi . Use of multiple drives to prevent resistance development has been suggested as another option.

As expected there has been a huge backlash from ecologists and environmentalists. The concerns have ranged from consequences due to inadvertent escape in experimental studies, breakdown of species barriers, emergence of new disease-transmitting vectors and the unknown ecological and environmental consequences of eliminating an insect species. Altered male mosquitoes released in Florida to contain Zika virus were not self-propagating. The challenge is to halt the gene drive when required, so that application can be restricted to limited geography.

The arguments are all reminiscent of the concerns expressed with GM crops, which are actually not self-propagating. In India, where even Btbrinjal is considered as an environmental risk, gene drive, even if technically feasible after years of research, may be made to hibernate for ever.

Of course, as Bangladesh has benefited by picking up our Btbrinjal clone, Africa may benefit employing the gene drive to contain malaria, thanks to Gates Foundation!

IIT Hyderabad develops novel skin patch for constant drug release

Researchers at the Indian Institute of Technology (IIT) Hyderabad have developed a novel drug-delivery system that releases a commonly used pain killer (diclofenac sodium) at the target site in a controlled fashion such that there is constant release of the drug for as long as 12 hours. The drug has low half-life of one–two hours and so constant release for up to 12 hours becomes particularly significant.

In normal circumstances, the drug gets metabolised very quickly, thereby requiring frequent dosing to maintain the desired therapeutic levels. The fluctuation of the drug plasma level is one reason why the medicine cases adverse effects.

To prevent burst or quick release of the drug, a team led by MudrikaKhandelwal from the Department of Materials Science and Metallurgical Engineering at IIT Hyderabad fabricated a transdermal patch containing the drug and made the patch highly hydrophobic (water repelling). The high hydrophobicity of the patch ensures that the highly water-soluble drug is released in a slow and sustained fashion. The results were published in the journal Applied Surface Science.

Tuning the patch

What makes the transdermal patch particularly significant is the freedom to increase the amount of drug present in the patch so that the drug is constantly released at a therapeutically

desirable dosage for a longer duration.
The patch was prepared by mixing the drug with cellulose acetate bio-polymer and electrospun in the form of a nanofabric. Ordinary nylon mesh with different pore sizes (50, 100 and 200 microns) was used at the site of the collector and this allowed the nanofibres to get deposited with micron-sized gaps in between.
"The non-wetting capillary action of the air pockets pushes the water away and this changes the water contact angle from about 30 degrees to 138 degrees and makes the nanofabric hydrophobic.
There is higher non- wetting capillary action of the air pockets when the air gaps are smaller in size," says Prof. Chandra Shekhar Sharma from the Department of Chemical Engineering at IIT Hyderabad and one of the authors of the paper. "Since the drug is released through a diffusion process, the increased water repelling nature (hydrophobicity) of the fabric reduces the effective area in contact resulting in reduced diffusion rate, which also reduces the drug release."

Constant release

"The drug, which is embedded in the transdermal patch, is released at a constant rate for up to 12 hours, when the pore size of the nanofabric is 50 microns. We achieved constant release for only three hours when the pore size was 100 microns. The drug without any micropatterning was released in just one hour," says Dr. Khandelwal who is the corresponding author of the paper.
"We tested transdermal release using a membrane that mimics the skin. The membrane separates the drug-loaded nanofabric from a solution that in turn mimics the body fluids," says Dr. Khandelwal. "Different drugs can be loaded in the nanofibres to achieve constant release for a long time."
"We embedded ciprofloxacin antibiotic in the patch and achieved similar results. The transdermal patch loaded with the pain killer [diclofenac sodium] can be used for treating local muscular pain. It may not be possible to treat deep-seated pain using this patch," says ShivakalyaniAdepu from the Department of Materials Science and Metallurgical Engineering at IIT Hyderabad and the first author of the paper.
The researchers plan to develop transdermal patch prototypes and test them on animals.

IIT Bombay's very low power water filter

Unlike the conventionally used reverse osmosis which is energy-intensive, desalination of tap water to make it potable (less than 200 ppm of ions, which is the WHO standard) is now possible by using very low power. The water filter can desalinate water as it trickles down the electrodes by gravity thus eliminating the need for any water pumping system.
The water filter developed by a two-member team led by ChandramouliSubramaniam from the Department of Chemistry at the Indian Institute of Technology (IIT) Bombay has a high desalination rate and capacity; one gram of electrode can remove 139 mg of salt (calcium, magnesium, sodium and potassium ions) at a rate of 3 mg of salt in one minute. The efficiency of ion removal is high at about 84%. The results were published in the journal ACS Applied Materials and Interfaces.
"Our electrodes have more than three times higher salt-removal capacity and two times higher salt-removal rate, which make them the best among all known materials, says Prof. Subramaniam. The researchers used a novel way to produce the electrodes which are used for capacitive deionisation to remove salt from water. Carbon nanotubes were synthesised and cellulose thread was dip coated with these

nanotubes. The dried carbon nanotube thread was then closely wound across flat copper plates to produce the electrodes.

Synergy

While carbon nanotubes are hydrophobic in nature, cellulose thread is highly water-loving (hydrophilic). By combining the two the carbon nanotubes thread becomes hydrophilic — water shows initial contact angle of 63 degree which then reduces to 15 degree in 30 seconds contact time. The highly hydrophilic and mesoporous nature of the thread combined with nano-sized pores and high surface area of nanotubes allow the ions to be effectively and quickly removed from water. "Achieving the right combination of surface area and porosity is critical to achieve this high performance," says Prof. Subramaniam.

Two electrodes are placed one above the other and separated from each other by 2 mm. The water flows between the plates in a narrow channel of 60 mm length, 6 mm breadth and 2 mm height. "We have currently tested with flow rates of 6 ml per minute" he says. "The volume of water filtered can be scaled up by having a larger channel using longer and wider electrodes," says MakuMoronshing from the Department of Chemistry at IIT Bombay and the first author of the paper.

The cost of materials to make the device is less than Rs.3 per sq. cm. The device (60 mm x 6 mm x 2 mm) tested in the lab requires only 0.15 mW power and can be operated with a pen-torch battery.

The electrode has to be deionised after 15-20 ml of water is collected. The researchers tested the electrodes for five cycles with very little change in performance. The electrodes can be recycled using deionised water or by changing the polarity of electrodes. It will take about one minute if deionised water is used and 15 seconds if polarity is reversed. "The water that comes out for 15 seconds when the polarity is reversed should be rejected as waste water," Prof. Subramaniam says.

"We would really like to take this forward to a commerical scale. We are currently exploring options with both DST and industries to help us set up a pilot scale plant and improve the technology readiness level," Prof. Subramaniam says. "We have filed for an Indian patent and we are open to direct licensing of technology to any company."

Mind and medicine: Placebo and nocebo

When a clinical researcher or a pharmaceutical company wants to check whether a new medicine or treatment (a pill, injection etc) works, they choose a large-enough set of patients for the clinical trial. They are divided into two groups. One of them is given the actual treatment (pill or the injection). The other is chosen as the control group; this is given not the actual treatment, but a "dummy" pill or injection. Neither group knows who gets what, but believes that they get the right one. The idea behind this comparative experiment, which lasts for 4- 6 weeks, is to check whether the treatment works, how safe it is and what side-effects it may have — positive or negative.

The trials

Prior to the start of the trial, the researcher calls every participant and explains to him/her that this is being done to check the safety and efficacy of the trial and what possible side effects (positive and negative) could be faced, and asks each of them whether they consent to the trial. He also tells then that they are free to withdraw from the trial at any time and for whatever reason.

The reactions of the participants are of interest. Some of them say they already feel good. This

is regardless of whether they were in the group that was given the drug or only offered the dummy. This phenomenon is termed the "placebo effect," the name coming from the Latin phrase "placebo" meaning "I shall please." The fact that they are being cared for already generates psychological benefit to them. This is not very different from how some people already feel better when they visit their friendly family doctor.

You can even mislabel a dummy pill as a brand-name drug, and some patients find that it works! A group led by Dr. Rami Burstein of Harvard Medical School labelled a placebo as the drug Maxalt (which is used to treat migraine headaches) and found it to be acceptable to many patients! While Maxalt treatment was clearly superior, the placebo effect increased in some participants. This indicates that labelling influences placebo.

Some patients are taken in by the price factor. They feel that the more expensive a drug is, the better it must be! A group led by Dr Dan Ariely of MIT recruited 82 people to test the efficiency of a painkiller drug. To one set they gave the drug priced at $2.50 per pill, and tested their ability to withstand the pain generated by an electric shock. To another set of 41 people, they gave the same drug sold at a attractive discount and tested their ability to withstand the same strength voltage-generated shock. The one who got the discount priced drug claimed they could bear far less pain then those who got the regular price drug. There appears to be the belief that a costlier product is better. Is this not what one sees even with cosmetics and several other consumer products? Many companies exploit this belief by wrapping their products in fancy packages and enticing the buyer — placebo in action.

Clinicians and researchers have also noticed the opposite of placebo occurring among some participants. Here the participant anticipates and feels adverse or negative reactions to a treatment. Dr. Walter Kennedy, who researched on this phenomenon coined the term "nocebo" in 1961, meaning "I shall harm you", as the counterpart of placebo. Doctors mention that even telling the participants that a treatment might have some minor side effects — an itch or some pain — is sufficient for some to feel it.

A striking example of nocebo in action comes from a paper by Dr. Tinnermann and others in the October 6 issue of Science, with a commentary on it by LuanaColloca. They got the same skin cream packed in tow identical looking boxes — one marked at a higher price while the other was marked cheaper. They further warned that though the cream relieves itch, there might be a slight pain. The volunteer group that opted for the more expensive box said that they felt a little more pain than the group that opted for the less expensive box. The researchers, during the trial, also did imaging of the spinal region and the front part of the brains of the volunteers. The neural activity in the group that chose the costlier box was distinctly higher. The fact of the matter was — that the cream neither cured itch nor caused no pain at all! Colloca writes: "the anticipation of painful stimulation makes healthy study participants perceive non-painful and low-painful stimulations as painful and high-painful, respectively. Verbally induced nocebo effects are as strong as those induced through actual exposure to high pain".

Shared decision-making

Professional medicine as a science is one side of the coin. The placebo–nocebo duality demands an understanding and allowing for the socio-psychological features of the patient, and this is the other side of the coin. The former is rigorous, meant for the body, and a "science." The latter is individual-specific and, as some

claim, is “art.” The care of the patient must thus involve what has come to be called as “shared decisionmaking” or SDM. It thus has an ethical dimension to it. A friendly, family doctor has been practising SDM. Hospitals, drug companies and insurance companies need to introduce SDM.

Given the numbers and the money involved, this is not easy, but not doing so has ethical implications.

Sight restored, children identify faces

Children born visually impaired due to cataract and who gained sight through surgery were able to differentiate faces from non-faces in about two months with over 90% accuracy, a study reports. The kids were also able to recognise by sight the objects they knew by touch in just about a week’s training. Five children aged 9-17 years thus regained sight showing that the brain retains the ability to acquire certain sensory skills even after several years of impairment.

“There is a general notion that kids who are born visually impaired [due to cataract] cannot gain sight beyond the first few years of life. But this appears not true in many cases. Current medical facilities can treat defects in lenses and corneas, and the brain can then begin to learn about the visual world,” explains Prof. Tapan K. Gandhi, Department of Electrical Engineering at IIT Delhi and first author of the paper published in the Proceedings of the National Academy of Sciences .

“We can’t call these children as totally sightless, since structurally the eye may be normal and vision potential exists. They can certainly gain vision once the cataract is removed. The quantum of improvement may depend on factors like density or position of cataract. The reason for cataract in several cases is not known, though a major part is played by intra-uterine infection in the pregnant mother due to rubella virus,” explains Dr. SumitaAgarkar, Deputy Director, Department of Paediatric Ophthalmology at SankaraNethralaya, Chennai who was not associated with the work. “We have done such sight-restoration surgeries in infants as young as six weeks and even on a 25-year-old man.”

Treatment and testing

The children for the surgery were identified through an initiative called Project Prakash started by Professor Pawan Sinha from MIT, the corresponding author. Five children from Uttar Pradesh and Rajasthan with dense bilateral cataracts were operated upon in 2011.

The researchers examined the children’s ability to classify images as ‘faces’ or ‘non-faces’. The children were shown 300 images that ranged from non-faces and facelike images to genuine faces. The face classification performance was very poor initially. The test was repeated after a week and every month up to two years. “The face is one of the most complex objects in the world... We saw steady improvement in the facial classification skills of the children,” Prof. Gandhi adds.

This study addresses a long-standing question of whether skills can be developed later in life, after the critical early age of development, and whether the brain can meaningfully interpret the visual world.

The researchers also found that patients can quickly learn to connect touch with sight. They were made to identify shapes blindfolded and then were made to see and identify. Within weeks after the surgery, kids could connect what they touch to what they saw.

Though they do not develop vision as sharp as normally sighted people’s, the brain quickly acquired the ability to identify objects, shapes, and faces. The results were published in Nature

Neurosciences .

"We found that although the brain does not possess cross-sensory mapping immediately after sight onset, it can acquire it after as little as a week of experience. We hypothesise that the brain discovers similarities in the dynamic information generated when a child is exploring objects simultaneously through touch and vision. These results have implications about brain plasticity as well as about strategies of sensory learning," explains Prof. Sinha in an email to The Hindu.

A bright spark for brain imaging and therapy

A new nanocluster that is able to cross the blood–brain barrier has been developed by scientists at SreeChitraTirunal Institute for Medical Sciences and Technology (SCTIMST), Thiruvanathapuram. The fluorescent gold nanocluster of size 1.7 nanometre can be used both as a carrier of drugs to the brain and for imaging the brain for tumours and other disorders. The results were recently published in the Journal of Materials Chemistry B.

The blood–brain barrier is a highly selective semipermeable membrane that separates the circulating blood from the extracellular fluid in the central nervous system (brain). Most of the drugs cannot cross this barrier without disrupting it, and this is a major challenge in treating brain disorders. The nanocluster was able to cross the barrier without causing disruptions.

Facilitator

To enable the nanocluster to cross the barrier, the researchers coated the gold nanoparticles with glutathione. "Glutathione is a tripeptide and is found virtually in every cell of the human body and so has no safety concerns. The glutathione also facilitates the uptake of amino acids into the brain," explains Dr R.S. Jayasree, scientist at the institute and the corresponding author of the paper. "For targeted and enhanced entry of the gold cluster, a brain targeting amino acid (L-dopa) was added. In mice models, the nanocluster injected intravenously reached the brain almost completely in just few minutes."

"We can tune the fluorescence emission to any wavelength by controlling the conditions like pH, temperature etc. during the synthesis of the cluster. We chose near-infrared wavelength, as otherwise, emissions from our body will hinder the imaging of the tumour," she adds.

For drug delivery studies, a model drug pilocarpine (a seizure-inducing agent) added to the nanoparticle was injected into the mice. The animals showed the preliminary neurological symptoms, but never had seizures, indicating that the gold nanoclusters released the drug slowly.

The new nanocluster can be used for the early stage diagnosis and treatment of neurological diseases when the barrier is not disrupted or loosened, the authors claim.

More studies are required before going for human clinical trials since the blood–brain barrier varies from species to species.

AstroSat's take on Crab nebula baffles astrophysicists

The Cadmium-Zinc-Telluride Imager (CZTI), an instrument to observe and image hard X-rays on board the Indian space observatory AstroSat, has consistently been making important observations since AstroSat's launch in 2015. The latest discovery, published in Nature Astronomy, is a polarization analysis of the Crab nebula pulsar that has completely baffled astrophysicists studying pulsars.

Polarimetry

In this work, observations of the Crab pulsar made by CZTI have been analysed in the so-

called phase-resolved X-ray polarimetry – a measure of the polarization of X-ray beams emanating from it. The experiment determines the magnitude and orientation of the polarization of the hard X-ray beams. This is the most sensitive and precise measurement of this variable until now. An analysis revealed that the values are contrary to what is predicted by all existing theories of pulsars.

Stars that have masses beyond a critical value of about 1.4 times the mass of our Sun will in the course of their lifetime explode to form a supernova. Even as some matter escapes from the explosion to create a glow, the remnant at the centre shrinks to become a black hole or a neutron star. The Crab nebula, in the Taurus constellation, is one such supernova remnant that has become a type of neutron star known as a pulsar. Known as the Crab pulsar, this emits electromagnetic radiation in a beam and also spins rapidly so that distant observers see the beam as a pulsating spot of light, justifying the name "pulsar."

Million cycles

"The Crab pulsar pulses once every 0.33 seconds and the data acquired by CZTI after observing millions of such 0.33-second cycles over a period of a year and half were analysed to get this result," says Varun Bhalerao of Indian Institute of Technology, Bombay, one of the researchers involved.

The pulses of radiation from the Crab pulsar show two peaked shapes coinciding with its north and south poles. In between these two high regions is a low-intensity, zero point called the off-pulse region. CZTI detected non-vanishing polarization having a definite varying structure in the off-pulse region where no variation was expected. "Since in the off-pulse region is dominated by radiation from the nebula [the cloud-like matter spreading away from the centre], the polarisation is expected to remain a constant here. But it certainly swings [varies with a definite shape]," says DrBhalerao.

Existing theories predict that there should not be such a variation of the polarisation. However, since the experiment has been repeated several times and the signs persist, it has forced theorists to rethink their theories of pulsars.

The extremely sensitive measurement was possible mainly because of the way the instrument was built and systemic errors were understood, he adds.

RESEARCH-DNA-SPECIES

Scientists have developed a portable DNA barcoding kit that makes rapid species identification possible for port of entry officials within a few hours. SujeevanRatnasingham, creator of the LAB-IN-A-BOX, from the University of Guelph, said the tool could be used to combat trafficking of threatened animals and plants.

Measles vaccination decreases acute respiratory infection, diarrhoea

Researchers from the International Institute of Population Sciences, Mumbai have found that among children who received measles vaccination there was a decrease in acute respiratory infection and diarrhoea. The study was conducted based on data from five countries, namely, Republic of Congo, Ethiopia, India, Nigeria and Pakistan, and 12-59-month-old children were considered in the analysis.

Measles is a highly contagious disease transmitted through a virus belonging to the Morbillivirus genus. Children below five years are prone to the infection. "The virus cansupress the immune system leading to infection in various organs of the body. Pneumonia and diarrhoea occur either as a complication or as a secondary infection," explains Rahul Bawankule, research

scholar at the institute and corresponding author of the paper published in PLOS ONE.

In 2010, diarrhoea and pneumonia were responsible for over 600,000 deaths of children in India under-5. India along with four other countries accounted for nearly 50% of the deaths globally from diarrhoea and pneumonia in this age group.

Surveys and analysis

The study is based on data from recent rounds of surveys from Demographic and Health Surveys in the selected countries. The survey collects information on vaccination status of children born in last five years. The mean age of measles-vaccinated and unvaccinated children and any occurrence of acute respiratory infection and diarrhoea after the vaccination were examined.

Researchers also examined the effect of socioeconomic and demographic risk factors on occurrence of acute respiratory infection and diarrhoea. These risk factors included cooking fuel, toilet facility, source of drinking water and household wealth status.

In India, 62% of the children were vaccinated. In all countries, the vaccination coverage was higher in urban than in rural areas. In India, vaccination reduced acute respiratory infection cases by 15% and diarrhoea by 12%.

“Measles vaccination works as a preventive measure against the complications or secondary infections. There are several other causative pathogens for pneumonia and diarrhoea also. Our study shows the protective effects of measles vaccination on acute respiratory infection and diarrhoea in countries which report the highest number of child deaths. Measles vaccination campaigns must highlight the many preventive benefits of the vaccine as well,” he adds.

First U.S. baby from womb transplant

The first birth as a result of a womb transplant in the United States has occurred in Texas, a milestone for the U.S. but one achieved several years ago in Sweden by Dr Mats Brannstrom who has, as of last year delivered five babies from women with donated wombs.

A woman who had been born without a uterus gave birth to the baby at Baylor University Medical Center in Dallas. Hospital spokesman Craig Civale confirmed that the birth had taken place, but said no other details are available. The hospital did not identify the woman, citing her privacy.

Baylor has had a study underway for several years to enrol up to 10 women for uterus transplants. In October 2016, the hospital said four women had received transplants but that three of the wombs had to be removed because of poor blood flow.

IISc: Etched aluminium keeps surfaces bacteria-free

Now, hospital-acquired infections can be reduced by using etched aluminium surfaces in ICUs, operation theatres and other places as well as by using them on regularly used objects such as taps, bedside tables, hand rails to name a few where transmission of bacterial infections is high.

Like shark skin and wings of cicada and dragonfly that are free of any pathogens, a team of researchers led by Kaushik Chatterjee from the Indian Institute of Science (IISc), Bengaluru used etched aluminium to kill both drug-sensitive and drug-resistant bacteria and also prevent bacteria from attaching and growing on the surfaces.

The aluminium surfaces have very minute textures produced through chemical etching which kills the bacteria and is responsible for antifoul-

ing.

In the case of drug-resistant bacteria isolated from a hospital, the etched surface that had both nano and microscale features killed 82% of E. coli (control 10%), 25% of K. pneumoniae (control was just 1%) and 86% of P. aeruginosa (control 10%). The etched surface also showed effective antifouling property against all the three drug-resistant strains.

While surfaces with both nano and microscale features killed 94% of E. coli and resisted bacterial adhesion and growth, surfaces those that had only microfeatures killed only 18% of E. coli and prevented the bacteria from adhering to it. Gram-negative bacteria such as E. coli are responsible for up to 70% of infections in ICU alone.

Though the precise mechanism by which the bacteria gets killed is not known, like the wings of cicada and dragonfly, the nanoscale features appear to mechanically rupture the bacterial cell membrane due to physical interaction of the cells with the surface topography. The microstructures limit the ability of the bacteria to adhere to the surface.

Bacterial isolates of E. coli and S. aureus were used for the antibacterial studies. Though only fewer spherical-shaped S. aureus were killed by surface topography, there was significant reduction of the bacteria on the surface. There was one-third reduction in S. aureus adhering on the surface that had only micro-features, and one-tenth reduction on surfaces had both nano and micro-features.

“Unlike the rod-shaped E. coli, the spherical shape of S. aureus results in fewer contact points with the surface and less likelihood of getting killed,” says Jafar Hasan from the Department of Materials Engineering at IISc and first author of the paper published in the journal Materials & Design.

Using sodium hydroxide and potassium hydroxide of different concentrations to etch the aluminium alloy for different time periods (10 to 60 minutes), the researchers were able to keep the surfaces nearly free of Gram-negative bacteria. “Etching aluminium surface is not only a simple, single-step process but can also be scaled-up easily,” says Dr. Hasan.

“We are engaging with people who are responsible for infection-control in hospitals to know the specific locations where the material can be used. They might either want aluminium foil with these surface properties can be regularly replaced or permanent fixtures,” says Prof. Chatterjee. “We have not studied the long-term durability of the surface features and their effectiveness. The durability will depend on how often such surfaces are handled by people.”

“A combination of five surface roughness parameters resulted in maximum (over 80%) bactericidal efficiency,” says Dr. Hasan. “The study proposes topography-based design rules of surfaces that can kill bacteria. The design can be efficiently transferred to other materials for bacteria killing property.”

IISc: HIV drug elvitegravir lowers the efficiency of immune system

Progressive depletion of certain immune cell — CD4+ T-cell — populations along with impairment of cellular immunity is responsible for the onset of AIDS in the case of HIV-positive people. Now, researchers from the Indian Institute of Science (IISc) Bengaluru, have shown that two FDA-approved drugs (raltegravir and elvitegravir) used for treating HIV actually impairs the immune system to varying extents. Both these drugs are widely used and are part of the combination anti-retroviral treatment.

In the presence of the drug elvitegravir, the mature B cells responsible for immunity showed a reduction in animal studies. The reduction was

pronounced — 70% of the mice studied showed a decrease in mature B cells.

The drugs target the HIV integrase protein that is responsible for the integration of viral DNA into human genome. HIV is a retrovirus which contains RNA instead of DNA. So when HIV infects human cells, the RNA is made into complementary DNA (cDNA) and this cDNA gets integrated into the human DNA. The viral DNA then makes copies of itself and then more viral particles are made, which then further infect more T cells.

Integrase and Rag1

Although integrase protein is specific to HIV, it shares structural and functional similarity with a protein present in humans called RAG1 (recombination activating gene 1). RAG1 is an integral protein of the immune system, and without it different antibodies cannot be developed leaving humans immune-deficient.

The team led by Prof. Sathees C. Raghavan from the Department of Biochemistry at IISc found that owing to the structural and functional similarity between the two proteins (RAG1 and integrase), the drugs designed to target HIV integrase protein can also bind and hamper the functions of RAG1 protein that is responsible for generation of antibody diversity leading to maturity of B cells of the human immune system. The results of the study were published in the journal Cell Death and Disease.

The researchers carried out in vitro studies using purified RAG proteins, and also studied the effects of the drug on human cell lines and on mouse models. In vitro studies showed the elvitegravir drug inhibiting binding and cleavage of human DNA in a dose-dependent manner. “Inside the lymphoid cells, DNA cleavage is important for the generation of antibody diversity. We found the drug significantly decreases the RAG1 function. When the drug binds to it and prevents DNA cleavage, it results in compromised antibody diversity,” says Prof. Raghavan.

While raltegravir drug did not cause significant inhibition of binding and cleavage of human DNA, these were impaired in the presence of elvitegravir drug. Cleavage inhibition was seen even at a low dosage of 50 microMolar, and “distinct” inhibition was seen when elvitegravir drug concentration was 200 microMolar.

“The structure of the two drugs is not the same. Elvitegravir drug probably binds tightly to RAG1 protein causing significant inhibition in cleavage,” says Namrata M. Nilavar from the Department of Biochemistry at IISc and one of the first authors of the paper. MayilaadumveettilNishana is the other first author of the paper.

“The elvitegravir drug caused significant effect on immune system when an extrachromosomal assay was used to study its effect inside the cells. We saw a threefold reduction in immune activity at 100 nanoMolarconcentration and eightfold reduction at 1,000 nanoMolar concentration,” says Prof. Raghavan.

Mice models

Mice were treated with eight doses of elvitegravir drug at comparable dosage as used in humans. “We looked at how the drug affects the growth of different stages of B cells, which are responsible for robust immune system,” he recalls.

“In about 70% of animals we found significant reduction in B cell population, while 30% animals remained unaffected.”

“More studies have to be done before we can say that continued use of elvitegravir drug by HIV positive people may be counterproductive,” says Nilavar.

“In humans, the duration of treatment is longer. So the damage may be much higher. Based on our study we can say that use of elvitegravir may have side-effects on the immune system.

Therefore, patients undergoing the treatment need to be monitored with utmost care," Prof. Raghavan stresses.

NCCS' novel approach improves success rate of bone marrow transplantation

Currently, haematopoietic stem cells (HSCs) taken from older donors for bone marrow transplantation have lower efficiency and capacity to engraft in recipients thus limiting their usefulness. But all this is set to change. Researchers from Pune's National Centre for Cell Science (NCCS) have found novel ways to rejuvenate the haematopoietic stem cells taken from aged donors and restore their functionality prior to transplantation to improve their engrafting efficiency.

A team led by Dr. Vaijayanti Kale from the Stem Cell Lab at NCCS co-cultured aged haematopoietic stem cells and young mesenchymal stromal cells for 36 hours. The brief exposure was sufficient to rejuvenate the stem cells and improve their functionality. The improved functionality of stem cells increases their engraftment capacity when transplanted and improves the success rate of bone marrow transplantation. The results were published in the journal Stem Cells.

Micro-vesicles

The researchers found that micro-vesicles from young mesenchymal stromal cells harbour significantly higher levels of autophagy-inducing mRNAs. The more the autophagy-inducing mRNAs the better is the ability of cells to destroy older cell components leaving room for the generation of new, younger cell components.

They found that transfer of micro-vesicles (containing significantly higher levels of autophagy-inducing mRNAs) from young mesenchymal stromal cells to aged haematopoietic stem cells during co-culturing leads to rejuvenation and improved functionality of stem cells.

"We found that young micro-vesicles reduced the proliferation of aged stem cells but improved their functionality in mice that received the stem cells," she says. "The improved functionality came from autophagy-inducing mRNAs present in the micro-vesicles."

"Tissue matching is not necessary for the use of stromal cells and thus can be taken from unmatched donors. Anyway, the stromal cells will not be transplanted. They are only used for co-culturing to provide the micro-vesicles. So bone marrow transplantation will not be compromised by using stromal cells for co-culturing," says Dr. Kale.

Another method

As mesenchymal stromal cells age they tend to exhibit activated AKT signalling. This leads to the accumulation of two microRNAs in the exosomes; exosomes are another type of extra-cellular vesicles. When the exosomes with the two microRNAs get into stem cells it leads to the loss of autophagy-inducing mRNA in the stem cells. As a result, the stem cells become less functional.

"We found that treating the old stromal cells with chemical inhibitors blocks the AKT signalling and this makes the stromal cells 'young-like'. The transfer of exosomes with inhibited AKT signalling from stromal cells into stem cells improves the functionality of the stem cells, just like co-culturing the aged stem cells with young stromal cells," says Dr. Kale.

Older stem cells from a donor are co-cultured with young stromal cells taken from the placenta or cord blood or from the marrow of young donors to improve the functionality of the stem cells.

Alternatively, by using chemical inhibitors to block AKT signalling, the stromal cells and stem cells can be taken from the same donor who is

old and co-cultured prior to transplantation.
"Our work on mouse models shows that such short-duration, in vitrorejuvenation of aged haematopoietic stem cells will expand the pool of donors for bone marrow transplantation and other regenerative therapies," she says.

One gene to tackle all stresses

Different types of stress can affect the life of plants including that induced by pathogens (biotic stress) and that caused by non-living entities such as drought, osmotic stress, chemical or salt stress and so on (abiotic stress). For a long time, researchers have been trying to understand the genetics of stress, and now a collaboration of scientists from Bengaluru's National Centre of Biological Sciences (NCBS) and Indian Institute of Science (IISc) has discovered a single gene whose expression controls the plants' response to both biotic and abiotic stress. This finding can be used to engineer plants that can withstand, for instance, drought or bacterial infections. The research has been published inPlant Molecular Biology.

Unrelated stress

"Previous studies at best identified genes that provide resistance to diverse abiotic stresses that are connected physiologically. For example, drought and salt stress are related and one single gene could provide resistance to both," says P.V. Shivaprasad, professor at NCBS. The novelty of this research is that it proposes that by expressing a single gene, it is possible to develop resistance in plants to various diverse and unrelated types of stress.
It has been known that the accumulation of an aldehyde – methylglyoxal – above a certain level can be toxic in all organisms. "Under normal developmental conditions, methylglyoxal levels remain very low (30-75 microM) and this regulates processes such as cell proliferation and their survival, and control of toxins," says Prof. Shivaprasad. However, the problem begins when this level increases beyond an optimum. Methylglyoxal is highly toxic in all organisms including humans at higher concentrations. "High levels of methylglyoxal targets proteins and DNA and modify them in such a way that they are non-functional," he adds.
Studying tobacco plants, the researchers have shown that overexpression of heat shock protein (Hsp31), which has the capacity to detoxify the plant cells of methylglyoxal, can render them highly tolerant to both biotic and abiotic stress. This protein – Hsp31 – is very similar to the PARK7 protein in humans which is linked to early onset of Parkinson's disease.

A timeline

SudhirSopory of Indian Institute of Science, Bengaluru (IISc) has done pioneering work on related proteins in plants and also demonstrated that their expression can provide abiotic stress tolerance in plants. Patrick D'Silva, also from IISc, had identified HSP31 in yeast as a methylglyoxalase that can offer abiotic stress tolerance in yeast. The NCBS team collaborated with the latter, whose lab provided clones as well as helped them with the biochemistry.
"We show that plant proteins similar to PARK7 are much more potent in their ability to remove toxins… It will be interesting to see if plant PARK7-like proteins can provide cure to neurological diseases through their activities," says Prof. Shivaprasad.

Natural composite for stronger bone grafts

A novel nanocomposite developed by researchers from CSIR-National Metallurgical Laboratory (CSIR-NML) has shown potential to be used as a regenerative bone graft especially in regions which need high strength. The nanocomposite was synthesised through a simple and cost-ef-

fective route. The composite contains carboxymethyl cellulose, gelatin and hydroxyapatite, with the hydroxyapatite in nanoscale (25-10 nm size).

The bone graft to be used in load-bearing application must match the strength of the natural bone. So the researchers evaluated the strength and elasticity of the nanocomposite and found it to be in the same range as human cancellous and cortical bone.

"All bone grafts need to be steam sterilised before use. So it is essential that the substance can withstand at least 120 degree C. Our new polymer nanocomposite is thermally stable up to 200 degree C. It is biodegradable and also accelerates the formation of new bone apatite under simulated body fluid," explains Chandrani Sarkar, PhD scholar at the institute and first author of the paper published in Journal of Material Science.

In vitro studies

They also examined the biocompatibility and proliferation of the human bone cell line (MG-63) cells in the presence of the nanocomposite. The human cells were found attached and had spread well on the surface of the nanocomposite indicating that they were well suited for cell growth and proliferation. They also observed that the nanocomposite accelerated the bone cell line for new bone tissue formation.

In vivo tests need to be carried out to get a full understanding of the nanocomposite.

There are several options available for replacement of damaged/diseased bones such using patient's own bone, donor's bone and metallic implants.

The risk of transferring diseases and chances of biological rejection from host body are very high in the case of bones transplanted from others (allo-graft). Metallic implants have high mechanical strength and mismatch with natural bone causing stress shielding and bone loosening which may damage or fracture adjacent bones.

"The compressive strength and modulus of our nanocomposite is in the range of human bone. So there is no risk of damage to adjacent bones after implantation. Importantly, the nanocomposite has regenerative property, with time it will be absorbed inside the body and new bone will be formed in that place. Unlike metallic implants, there is no need to take out our implants," explains Sarkar in an e-mail to The Hindu.

"We have already transferred know-how to industry and they are using our products," says Prof. Subhadra Garai, senior scientist and corresponding author at the Advanced Materials and Processing Division, CSIR-NML.

Artificial intelligence diagnoses asthma, identifies subtypes

Using machine learning, a field closely related to artificial intelligence, upon nuclear magnetic resonance (NMR) spectra of exhaled breath condensate, Delhi-based researchers have been able to improve the diagnosis of childhood asthma and even identify three asthma subtypes. This pushes the current understanding of childhood asthma towards having metabolomic (study of chemical processes involving metabolites) subtypes, which have been largely unknown so far.

A team of researchers led by Dr. Anurag Agrawal from Delhi's CSIR-Institute of Genomics and Integrated Biology (IGIB) and Dr. TavpriteshSethi from IIIT-Delhi and AIIMS has now achieved a measure of success. Theresearchershave been able to correctly identify children with asthma and also the subtypes along with potential biomarkers.

The study included 89 asthmatic children below

18 years and 20 healthy individuals with no history or clinical manifestation of asthma to identify the NMR signatures of asthmatic children; the NMR spectra of 61 asthmatic children with clinical data were used for identifying the subtypes. In an ongoing cohort at AIIMS, the children have been followed up for five years now, says Dr. KoundinyaDesiraju from CSIR-IGIB and one of the first authors of thepaperpublishedin the Journal of Translational Medicine .

Unlike other researchers who looked for specific metabolites in exhaled breath using NMR, Dr. Agrawal and Dr. Sethi looked for global NMR signatures of all metabolites from exhaled breath that was condensed at -80 degree C. "Unknown and highly variable dilution of exhaled breath has been a major problem in this field. Unlike in the case when specific metabolites are looked for, the overall shape of the signature will remain the same immaterial of the dilution of exhaled breath," says Dr. Agrawal.

But the challenge with studying global signatures is that human eye is not equipped to seeing hundreds of peaks and picking out a pattern. This is where artificial intelligence came in handy. The algorithm was able to differentiate the total NMR spectrum (which was normalised) of healthy children and those who had asthma. It could also identify three subtypes of asthma. The algorithm has 80% sensitivity and 75% specificity in identifying children with asthma.

"We could correlate the different subtypes with different clinical manifestations," says Dr. Agrawal.

Children belonging to subtype 1 showed a typical signature of ammonia metabolite but had no family history of asthma. "This asthma subtype is more like the typical allergic form of asthma," says Dr. Sethi. "But subtype 3 had lower blood eosinophilia and elevated neutrophilia compared with the other two subtypes. Children belonging to this subtype had a stronger family history of asthma and suffered from more acute asthma episodes even when on treatment." Subtype 3 showed a peak corresponding to formic acid.

Subtype 2 had high eosinophil count but was otherwise similar to subtype 1, but very different from subtype 3. "Not every chemical difference in exhaled breath will translate into clinical difference. To know if there is any clinical difference in children belonging to subtype 1 and 2, more children have to be followed up for a longer period of time," Dr. Agrawal says.

Currently, there is no difference in treatment for children belonging to three subtypes. "Knowing the difference between subtype 1 and 2 as one group and subtype 3 will help in better treatment strategies, which is the goal of precision medicine," Dr. Sethi says. "Children with subtype 3 asthma may need more aggressive therapy or alternative treatment strategy. But at this stage of the study we don't know the details."

The next step will be to validate the signatures as biomarkers of asthma subtypes. For this, the subtype 1 and 2 will be looked together and contrasted with subtype 3.

What the lizard and salamander can teach us

The lizard has never had a good press in India. Many communities are very worried about what evil may befall if a lizard from the ceiling falls on our body. Some worry that if it falls on our head, it foretells our early death. If it falls on the toe, there could be physical illness. Indeed, an ancient text called " GauliSastra " makes predictions based on where in our body the household lizard falls. Some Hindu almanacs (panchangams) carry excerpts from the above text. While such predictions are obviously far-fetched, the real wonder is how, in the first place, the liz-

ard is able to climb walls and move on the ceiling upside down. A healthy lizard does not fall off so easily. What makes this tiny animal possess such superhuman ability? This is a poser that has engaged scientists for over half a century. The first thought was that the toes in their feet create a temporary vacuum when they are placed on a surface. But this was proved wrong when the anatomy of their toes was analyzed. Each toe was found to have many thousands of tiny, spatula-tipped split hairs. It is this collective interaction between these hairs and the surface on which the lizard moves that appears responsible for this unusual ability of the animal.

How lizards climb walls

How does it work? This 'binding' between the hairs and the surface is very weak in itself. But when thousands of such hairs hit the surface, this tiny electric effect is somewhat enlarged. This induced electric force is termed induced dipole moment. (A real life example is when a child rubs an inflated rubber balloon. She now brings a piece of paper, and finds that the paper can stick to the balloon- thanks to the induced electric field generated upon rubbing, which attracts the paper). A simila induced temporary dipolar force causes the toes to stick on the surface of the wall. And the force is small enough for the toe to overcome the force and take the next step with no trouble, and the lizard moves on, as nimbly as a fashion model does on a catwalk.

This force, caused by such minuscule electrical 'bonding' of two substances, and which occurs at very close distances, was first recognized by the Dutch scientist Johannes Diderik van der Waals, and has become known as the van der Waals force. And when this force operates collectively by thousands of toe hairs in tandem, the effect becomes substantial and real-life. In effect then, lizards use the van der Waals forces to climb walls and stay on the ceiling. (Shave their hair off, they may no longer do such heroic acts). It also exemplifies the dictum: in unity and working together is strength.

How they do it

There is yet another superhuman thing that lizards do. Try and catch a lizard by its tail; the tail simply comes off and the lizard scurries away. And a few days later, it regenerates its lost tail! And the lizard is not alone in this act. Its amphibian distant cousins, the salamander and even the frog, can regenerate some of their damaged or lost tissues and limbs. Indeed, a salamander can regenerate its tail, spinal cord, cartilage and some parts of its eye. How do they do these and we humans are not able to? This question has engaged the minds of some scientists from across the globe.

It appears that once a tissue is damaged in the lizard or salamander, many cellular molecules zone in on the damaged or lost site, work on the region to regenerate the relevant cells and coordinate their assembly into the fresh, regenerated tissue. Some of these molecules are related to immunity, some to trigger cell growth and some to redirect the cells to assemble together to form the tissue of interest (cf. TP Lozito and RS Tuan, Lizard Tail Regeneration,Connect Tissue Res . 2017 March, 58(2), 145-154). Another report talks about how normal 'somatic' cells can be converted to tissue-regenerative stem cells through the use of two specific molecules (PDGF-AB and AZA; see V. Chandrakanthan et al. , PNAS(USA), 2016;www.pnas.org/cgi/doi/10.1073/ pnas.1518244113). Learning from these and similar papers, and attempting to do so with some human tissues are organs would be useful.

Some others have pointed out that the genetic contents (the genome) of the salamander and the human genome have many common genes-

some of them with some modifications. Based on this, one scientist has wondered whether "we can awaken the hidden salamander in us"! That is, attempt to find ways to trigger the action of the salamander-like genes in our genome, so that we too may regenerate damaged or lost tissues such as parts of our eyes.

This attempt has been termed as "an audacious goal". But the very fact a question has been raised would mean people will try to work on the goal, and hopefully in time score some success; after all. Nothing attempted, nothing gained.

Novel inhibitor to combat kala-azar identified

Combining structure-based drug designing methodology with in vitro studies, scientists have been able to identify a FDA-approved molecule that shows enhanced anti-kala-azar activity.

Three active inhibitor molecules were selected from the PubChem database and one of them showed the highest stability in binding to the active sites of the target enzyme (UDP-galactopyranose mutase or UGM) which helps in the formation of glycoprotein, beta-Galf. After binding to the UGM, the molecule inhibits the enzyme activity thereby reducing the virulence, parasite survival and transmission of disease. The results were published in the Journal of Cellular Biochemistry.

Limited treatment

Treatment for kala-azar (disease caused by Leishmania infection) is limited due to high toxicity to human cells, low efficacy of the drug, high cost and drug resistance making the development of novel anti-kala-azar drugs a priority.

India has around 3,000 people afflicted with kala-azar, accounting for 50% of the global burden. It is endemic in West Bengal, Bihar, Jharkhand and eastern Uttar Pradesh.

Beta-Galf is a major cell surface component of Leishmania parasite and is responsible for the virulence of the pathogens and plays an essential role in parasite survival and transmission of disease. Beta-Galf is also found inMycobacterium tuberculosis that causes TB and Trypanosoma cruzi parasite that causes sleeping sickness but is absent in humans. Like beta-Galf, the UGM enzyme is also absent in humans but is critical for the biosynthesis of beta-Galf thereby making the UGM enzyme an attractive drug target. Deletion of the gene encoding for the enzyme in L. major resulted in a decrease in virulence.

Since the protein structure of Leishmania UGM is not known, Dr. Yusuf Akhter and other scientists used the protein structure of T. cruzi UGM as a template and the protein sequence of Leishmania was modelled on the template. "There is 60% sequence identity between Trypanosoma UGM and Leishmania UGM," says Dr. Akhter from the School of Life Sciences, Central University of Himachal Pradesh, Kangra, Himachal Pradesh and one of the corresponding authors of the paper.

In vitro studies

One of the three chosen inhibitors was evaluated in vitro for anti- Leishmaniaactivity and found to significantly inhibit the growth of Leishmaniadonovani(which causes damage to visceral organs such as liver and spleen). Different doses of the compound were tested and the minimum inhibitory concentration or IC50 value (the lowest concentration of the compound required to inhibit the visible growth of a pathogen) was found to be 50 microgram per litre. The IC50 value of the approved drug miltefosine hydrate is only 25 microgram per litre.

But the approved drug miltefosine hydrate showed 100% toxicity to human cells when 50

microgram per litre was used whereas the toxicity of the screened molecule was only 50% at the same concentration. The toxicity of miltefosine hydrate was as high as 89% even when 25 microgram per litre (which is the IC50 value of the drug) was used.

"Even at half the concentration, the toxicity of the approved drug miltefosine hydrate is higher than the tested inhibitor," says Dr. Akhter. The screened molecule appears to have therapeutic efficacy with lower toxicity compared with miltefosine hydrate.

Though the protein sequence of Leishmania major was used, the in vitro studies using the screened molecule were carried out on Leishmaniadonovani.

"The UGM of L. major and the UGM of L. donovani have highly similar sequences. All the active regions are 100% identical. Hence these two can replace each other and a molecule that acts as an inhibitor for one protein will also act as inhibitor for the other. As the parasite strain available in the laboratory was L. donovani , the cell-based assays were performed on that," says Dr. Akhter.

Scientists link new virus to kala-azar

Researchers have stumbled upon tantalizing evidence of an unknown virus that may be responsible for the persistence of kala-azar or visceral leishmaniasis, a parasite infection that has spawned epidemics and sickened thousands of Indians for over a century.

It's still early to pointedly blame the virus but its discovery portends a new kind of treatment regime and may aid attempts to eradicating the disease.

Historically, the parasite Leishmaniadonovani is believed to be responsible for the dreaded infection. People get infected when bitten by an insect called the sandfly, which harbours the disease-causing parasite.

This month, a group of scientists from West Bengal and Uttar Pradesh said that another parasite may be involved. Another parasite called Leptomonasseymouri may also be present, according to Subhajit Biswas, one of the scientists involved in the study.

The researchers inferred this after they found the L seymouri and a virus called Lepsey NLV1 within it in 20 of 22 biological samples of patients who had a residual L donovani infection. They reported their findings in an online version of the peer-reviewed Archives of Virology.

Endemic to subcontinent

Kala-azar is endemic to the Indian subcontinent in 119 districts in four countries (Bangladesh, Bhutan, India and Nepal). India itself accounts for half the global burden of the disease. If untreated, kala-azar can kill within two years of the onset of the ailment, though the availability of a range of drugs has meant that less than one in 1,000 now succumbs to the disease.

However, scientists are still not clear how the parasites cause the infection and how they manage to hide within the body.

"So far researchers weren't looking for parasites other than donovani and hopefully this finding should lead to collaborations with other labs to explore this link," Dr. Biswas told The Hindu.

NBRC team uncovers how damaged neurons recover functions

Researchers at the National Brain Research Centre, Gurgaon, have experimentally demonstrated how neurons that are injured or damaged can be functionally restored by fusion of the severed axons. Neurons can break during accidental injury and day-to-day stress-induced injury. Carpel tunnel syndrome is a typical case of peripheral nerve damage arising from several severed axons.

Neuronal damage arises when the axons are

severed into distal and proximal fragments. Experiments carried out on Caenorhabditis elegans by a team led by Anindya Ghosh-Roy from NBRC has now shown how the touch sensation of the worms is restored when the two severed axon fragments fuse. The results were published in the Proceedings of the National Academy of Sciences.

"This is the first detailed cell biological study to show the basis of functional regeneration of damaged neurons in C. elegans, " says Dr. Sandhya PadmanabhanKoushika from the Department of Biological Sciences at the Tata Institute of Fundamental Research (TIFR), Mumbai, and one of the authors of the paper.

They also found that functional recovery takes place in an age-dependent manner, with better recovery in the late larval stage and less recovery in adult worms.

The researchers used two femtosecond lasers to locate and cut the axons involved in touch sensation. During regeneration, only the axons that successfully fuse with their distal counterparts contribute to functional recovery. "There is no fusion, there is no functional recovery," Dr. Ghosh-Roy says.

The researchers genetically proved that three molecules — ced-7, psr-1 and eff-1 — are essential for fusion. "In this study we showed that mutants lacking any of these three molecules show normal axon growth but fusion of the axons is perturbed. As a result, the touch sensation is not restored," says AtrayeeBasu, a graduate student from NBRC and the first author of the paper.

Dr. Ghosh-Roy's team has experimentally shown that let-7 mutants (worms that do have let-7 microRNA that is present in neurons) have higher amounts of ced-7 molecule. The ced-7 molecule is important for the recognition of the proximal and distal ends of the injured neurons.

"We have molecularly shown that the level of ced-7 is increased in the mutants. This leads to enhanced functional restoration," he says.

Effect of age

In humans, the ability to regenerate neurons gets reduced with age; the researchers have made similar observations in worms. In older worms, even when fusion takes place the functional restoration does not happen. It could be because the fusion is not complete.

The researchers used synaptic vesicles that travel from one end of the axon to the other to see if incomplete fusion prevents the vesicle movement or reduces the amount of vesicles travelling across the point of fusion to the distal axon.

"In larval stage we could see the synaptic vesicle movement across the point of fusion. But in adults, due to aging, only very few axons show vesicles moving from one end to the other. So the cytoplasmic continuity is compromised in the adult stage," says Dr. Koushika.

Complete fusion needed

The age-related decline in functional restoration is overcome in let-7 mutants. "In mutants, the vesicle transport is maintained in adults indicating that the fusion is complete; the mutants show functional restoration unlike in wild-type worms of the same age," says Dr. Ghosh-Roy.

The researchers carried out experiments to find out why despite fusion the cytoplasmic continuity is compromised in adults stage. They found that the amount of eff-1 protein at the tip of the growing axon is high in the larval stage. But in adult worms, the eff-1 enrichment is reduced.

In let-7 mutants, the amount of eff-1 protein at the tip of the axons in adult worms is high and this improves the cytoplasmic continuity.

Functional recovery after injury might come into play after spontaneous breakage of axonal process during day-to-day stress induced injury.

The finding that the fusion of the severed axons can be genetically improved raises hopes for treating nerve injuries in human in future.

The top ten genes of medical genetics

The human body is made up of cells, tiny factories that perform much of the action in the body. They make up tissues, which make up organs, which in turn make up the body. The cell is thus the ultimate action site. What cells do is governed by the information packed inside its head office — the nucleus. The information there is packed in the collection of chromosomes, each of which has this information written in the collection of genes. Genes contain this information for what a cell does, and hence the tissues and organs do, and the body itself does. An error in the information contained in one or several of the genes can reflect itself in the form of a malfunction in the tissue, organ or the body.

This information in the genes is written in the form of DNA molecules, each of which is a long sequence of four molecules, known as 'bases', strung together in a long polymeric chain. While the English alphabet has 26 letters and punctuation marks, the alphabet of the genes has four bases, called A, G, C and T, as letters. The sequence in which these are arranged makes the genetic words and punctuation marks.

Book of life

The human genome is the collection of information contained in the genes packed into the chromosomes, which in turn are packed inside the nucleus of cells. Our genome is thus our book of life containing chromosomes as chapters, each packed in sentences written in the genes, which in turn are coded in the collection and sequence of the four-letter genetic alphabet.

As the cell reads out the information stored in its chromosomes, it performs its action. The major part of this action is in the form of translating the genetic language into action molecules called proteins. In essence it is the reading out of the codes in the DNA software that leads to action in the cell and the "hardware," or the body.

It is an interesting fact of biological history that we had already started learning about and identifying genes before we understood the nature and chemical structure of DNA and the genetic code. The Austrian monk Gregor Mendel, experimenting with pea plants, between 1856 and 1863, identified inheritable traits or "factors" (we now call them genes) that form the colour of the flowers. That certain traits such as haemophilia run in families was understood as faults in genes, though how to read them in molecular terms was still far away.

Proteins in the body are made from the message inscribed in the genes. While it became possible to read the sequence of bases in the DNA of genes only in the last 50 years or so, reading the sequence of amino acids in protein chains became popular even by the 1950s. Scientists began studying the properties of proteins associated with diseases. Even one change in the amino acid sequence can sometimes lead to alterations in the properties of a protein and lead to health issues. As Drs Pauling and Ingram showed over 70 years ago, replacement of the amino acid 'glu' in the sequence of a haemoglobin molecule by the amino acid 'val' changes its properties dramatically, leading to a form of anaemia.

Genetic basis of disease

Errors of this type in protein sequences often arise due to errors in the sequence of the parent genes. Once it became possible to read the sequence of the DNA in genes, it led to an understanding of the genetic basis behind the disease, and the field of medical genetics was born. With the rapid pace in which gene

sequencing has developed in the last two decades, medical genetics has flowered fast. Cancer genetics is a busy area, and a study of the genes associated with cancer has become popular. So has the field of understanding the genetic connection to Alzheimer's and similar neural disorders. The 23 November issue of the journal Nature lists the "Greatest Hits of the Human Genome." It points out that out of the 20,000 or so protein-coding genes in the human genome, just 100 account for more than a quarter of scientific papers and reports published! And out of this 100, there are but 10 genes that are most studied and thus on the High Table.

And of this ten, the topper is the gene for the protein named as p53. This protein has a role in suppressing tumours. No wonder it has been studied in 8,479 publications. Next to p53 is the gene for TNF, coding for another molecule called tumour necrosis factor, which plays a role in killing tumour cells; this has been discussed in 5,314 publications. Fifth in the list is the gene termed APOE, studied in 3,977 papers. The coded protein APOE is associated with a risk of Alzheimer's disease. The reason behind these large citations is the hope that once we understand the molecular basis of a disease, we may devise treatment modes, which focus on the genetic, and hence, the cellular basis behind the disease. Thus the Top 10 hits here do not represent a fashion parade or a Guinness Book entry, but a reflection of the attempts to alleviate human suffering through medical genetics.

IISc: Etched aluminium keeps surfaces bacteria-free

Now, hospital-acquired infections can be reduced by using etched aluminium surfaces in ICUs, operation theatres and other places as well as by using them on regularly used objects such as taps, bedside tables, hand rails to name a few where transmission of bacterial infections is high.

Like shark skin and wings of cicada and dragonfly that are free of any pathogens, a team of researchers led by Kaushik Chatterjee from the Indian Institute of Science (IISc), Bengaluru used etched aluminium to kill both drug-sensitive and drug-resistant bacteria and also prevent bacteria from attaching and growing on the surfaces.

The aluminium surfaces have very minute textures produced through chemical etching which kills the bacteria and is responsible for antifouling.

In the case of drug-resistant bacteria isolated from a hospital, the etched surface that had both nano and microscale features killed 82% of E. coli (control 10%), 25% of K. pneumoniae (control was just 1%) and 86% of P. aeruginosa (control 10%). The etched surface also showed effective antifouling property against all the three drug-resistant strains.

While surfaces with both nano and microscale features killed 94% of E. coli and resisted bacterial adhesion and growth, surfaces those that had only microfeatures killed only 18% of E. coli and prevented the bacteria from adhering to it. Gram-negative bacteria such as E. coli are responsible for up to 70% of infections in ICU alone.

Though the precise mechanism by which the bacteria gets killed is not known, like the wings of cicada and dragonfly, the nanoscale features appear to mechanically rupture the bacterial cell membrane due to physical interaction of the cells with the surface topography. The microstructures limit the ability of the bacteria to adhere to the surface.

Bacterial isolates of E. coli and S. aureus were used for the antibacterial studies. Though only

fewer spherical-shaped S. aureus were killed by surface topography, there was significant reduction of the bacteria on the surface. There was one-third reduction in S. aureus adhering on the surface that had only micro-features, and one-tenth reduction on surfaces had both nano and micro-features.

"Unlike the rod-shaped E. coli, the spherical shape of S. aureus results in fewer contact points with the surface and less likelihood of getting killed," says Jafar Hasan from the Department of Materials Engineering at IISc and first author of the paper published in the journal Materials & Design.

Using sodium hydroxide and potassium hydroxide of different concentrations to etch the aluminium alloy for different time periods (10 to 60 minutes), the researchers were able to keep the surfaces nearly free of Gram-negative bacteria. "Etching aluminium surface is not only a simple, single-step process but can also be scaled-up easily," says Dr. Hasan.

"We are engaging with people who are responsible for infection-control in hospitals to know the specific locations where the material can be used. They might either want aluminium foil with these surface properties can be regularly replaced or permanent fixtures," says Prof. Chatterjee.

"We have not studied the long-term durability of the surface features and their effectiveness. The durability will depend on how often such surfaces are handled by people."

"A combination of five surface roughness parameters resulted in maximum (over 80%) bactericidal efficiency," says Dr. Hasan. "The study proposes topography-based design rules of surfaces that can kill bacteria. The design can be efficiently transferred to other materials for bacteria killing property."

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BIOTECHNOLOGY

IISc team fabricates nanomaterial to treat Parkinson's

A team of researchers from the Indian Institute of Science (IISc) Bengaluru has fabricated a metal oxide nanomaterial that is capable of mimicking all three major cellular antioxidant enzymes, thereby controlling the level of reactive oxygen species (ROS) inside cells. Based on in vitro test results, the nanomaterial appears a promising candidate for therapeutic applications against oxidative stress-induced neurological disorders, particularly Parkinson's. The results were published in the journal AngewandteChemie.

Reactive oxygen species, such as superoxide, hydrogen peroxide and hydroxyl radical, which are generated as part of a normal physiological process, are essential for the normal functioning of cells. Excess of ROS generated is usually controlled by the action of three antioxidant enzymes (superoxide dismutase, catalase and glutathione peroxidase).

Excess ROS

A problem arises when ROS is generated in excess and the enzymes are unable to control the level of ROS. Oxidative stress due to excessive ROS causes damage to DNA, proteins and lipids; oxidative stress is implicated in several diseases such as neurodegeneration, cancer, diabetes and cardiovascular diseases.

"We have developed a manganese oxide (Mn_3O_4) nanomaterial which functionally mimics all the three antioxidant enzymes. Earlier, we had shown that vanadium oxide (V_2O_5) nanowire is capable of exhibiting glutathione peroxidase enzyme activity," says Prof. Govindasamy-Mugesh from the Department of Inorganic and Physical Chemistry, IISc, and one of the corresponding authors of the paper. Nanomaterials with enzymelike activity are called nanozymes. "This is the first time the activity of all three major antioxidant enzymes are seen in a nanomaterial."

The researchers tried several morphologies and found the flower-like morphology had the best activity of all three enzymes. Pores present on the nanomaterial play an important role as enzyme-active sites and help in scavenging excess ROS. The larger pore diameter and pore volume capable of accommodating all the three ROS were found to be critical in determining the enzyme activity of the nanomaterial.

No toxicity

In vitro studies using human neuronal cell lines found that the nanomaterial caused no cellular toxicity when internalised by the cells and hence safe. Metal-based complexes are generally toxic to cells. "The nanomaterial was not toxic probably because manganese is naturally present in our body and is an essential trace element. It is not toxic up to a few microgram. This prompted us to use manganese-based nanomaterial," says Namrata Singh from the Department of Inorganic and Physical Chemistry, IISc and the first author of the paper.

The nanomaterial was found to protect against neurotoxin-induced cell death by scavenging the excess ROS that was artificially generated inside the cells.

"Inside the cells, the nanomaterial was able to substitute the cellular enzymes effectively when the enzymes are inhibited. Due to high pore size and volume, it was able to achieve better activity. So we don't need much of the nanomaterial inside the cells," says Prof. Patrick D'Silva from the Department of Biochemistry at IISc and the other corresponding author.

Optimum effect

"The manganese oxide nanomaterial was able to control the level of ROS inside the cells. They did not scavenge the ROS completely. If they do then the normal physiological functions of the cells get affected," says Prof. Mugesh. "It actually scavenges ROS and brings it to optimum level so normal functions of the cell are not affected."

The superoxide dismutase enzyme has two forms and one functions in the cytosol and the other inside the mitochondria. "Some amount of nanomaterial gets inside the mitochondria as well and controls the ROS produced there. The nanozymes have therapeutic potential particularly for Parkinson's disease," says Prof. D'Silva.

Parkinson's model was tested in the lab. The researchers are trying to design an animal model in mice for in vivo testing.

IIT-K: Antibodies to treat a few genetic diseases

Inherited genetic diseases such as retinitis pigmentosa and nephrogenic diabetes may become treatable if the initial results achieved by a team of researchers led by Prof. Arun Shukla from the Department of Biological Sciences and Bioengineering at the Indian Institute of Technology (IIT), Kanpur, are reproducible in animal models and humans.

Retinitis pigmentosa is an inherited, degenerative eye disease that leads to progressive loss of vision as one gets older, while genetic nephrogenic diabetes arises from kidney cells' inability to retain water leading to extreme thirst and dehydration. In both these cases, the cause of disease is a mutation in the G-protein-coupled receptors (GPCR) which causes the receptors to be pulled from the plasma membrane to the inside of the cell just as the receptors reach the cell membrane to start signalling. In the absence of the receptors (rhodopsin GPCR in the case of retinitis pigmentosa and vasopressin GPCR for genetic nephrogenic diabetes) the cells fail to signal and do not function normally.

The pulling in or trafficking of the GPCR receptors from the membrane surface to inside the cells (which is called endocytosis) happens when a small family of proteins called beta-arrestins bind to GPCR receptors and to another class of proteins called clathrin.

"We have designed synthetic antibody fragments which specifically bind to beta-arrestins at the position where clathrin gets bound. So our antibodies prevent the clathrin protein from binding to beta-arrestins thus preventing endocytosis," says Prof. Shukla. The results were published in the journal Nature Nanotechnology.

Theoretically, preventing the trafficking of the GPCR receptors from the membrane surface to inside the cells is like turning the clock back; rhodopsin and vasopressin receptors would stay intact on the cell membrane, start signalling and enable the otherwise mutant cells to function normally. "Our designer proteins provide unexplored territory for therapeutic applications for inherited diseases," he says.

Limited lifespan

Proteins such as GPCR receptors, beta-arrestins and clathrin have limited life span of a few hours, while the antibodies introduced survive for a loner time. Once introduced, the antibodies can get bound to beta-arrestins that are freshly produced and prevent clathrin from binding to beta-arrestins thus preventing endocytosis. "Even when beta-arrestins bound to antibodies decay, the antibodies with their longer life span can bind to newly formed beta-arrestins. The other possibility is increasing the concentration of the antibodies so that they are always present in the cells to bind to freshly produced beta-arrestins," Prof. Shukla says.

Since the mechanism of the two diseases is the same, the antibodies can work equally well immaterial of the cell type involved. "This is a proof-of-concept study using modified kidney cell lines. The next step will be to develop new strategies to deliver the antibodies into human live cells and animal models," he says. The team is considering starting these studies in near future.

The big advantage of using antibodies is that they selectively block receptor endocytosis but not signalling. "This provides a unique handle, currently not available anywhere in the world, for targeting a specific GPCR function. This makes our designer proteins superior to knock-out approaches," he comments.

IISER Bhopal: strategies to fight breast cancer

Inhibiting the growth and accelerating the death rate of breast cancer cells may be possible by starving the cancer cells of glucose or by inhibiting the energy production process (aerobic glycolysis). Aerobic glycolysis confers a proliferative advantage to the cancer cells. The results were published in theProceedings of the National Academy of Sciences.

A team of researchers led by Dr. Sanjeev Shukla from the Department of Biological Sciences, Indian Institute of Science Education and Research (IISER), Bhopal, has been able to reverse aerobic glycolysis by inhibiting DNA methylation or reducing the expression of BORIS (Brother of Regulator of Imprinted Sites) gene.

Alternative splicing

In normal cells, exon 9 gets included while exon 10 is excluded when precursor messenger RNA (pre-mRNA) is spliced or edited into mature messenger RNA (mRNA). The researchers found that splicing was different in the case of cancer cells — instead of exon 9, exon 10 gets included when the pre-mRNA is spliced into mRNA. "The methylation at exon 10 allows BORIS to bind to the exon 10 and leads to the inclusion of exon 10 in the mature mRNA," says Dr. Shukla. "Due to aberrant alternative splicing, exon 10 gets included in the mature mRNA leading to the formation of PKM2, a cancer-specific isoform of pyruvate kinase."

The PKM2 isoform is seen in cancer cells and is responsible for proliferation of cancer due to aerobic glycolysis while the PKM1 isoform is found in normal cells. The DNA methylation along with BORIS regulates the switch from PKM1 to PKM2 isoform.

This is the first time DNA methylation causing alternative splicing in cancer cells has been studied. DNA methylation also silences tumour suppressor genes.

"The BORIS gene is predominantly expressed in germ cells and gets over-expressed in cancer cells but not in somatic cells. So BORIS is a potential target for cancer

therapy," says Dr. Shukla.
The team studied two breast cancer cell lines and found increased exon 10 in both cancer cell lines but exon 9 was found to be increased in normal, primary cells. The presence of exon 10 in breast cancer cell lines led to higher expression of cancer-specific PKM2 isoform.
Unlike in normal breast tissue, the researchers found overexpression of BORIS in breast cancer subtypes in the Cancer Genome Atlas and Oncomine.

Potential targets

Inhibition of DNA methylation led to reduced binding of BORIS at exon 10 leading to reduced exon 10 and increased exon 9 in the mature mRNA. There was also a reduction in the cancer-specific PKM2 isoform and increase in the PKM1 isoform.
Similarly, depletion of BORIS gene led to reduced BORIS binding and decreased inclusion of exon 10 with a concomitant increase in exon 9 inclusion.
To rule out other factors responsible for alternative splicing of PKM, the researchers mutated the BORIS binding site at the PKM exon 10 region. "There was reduced exon 10 and increased exon 9 in the mutant cells. Also, there was reduced BORIS enrichment which resulted in reduced exon 10 inclusion in the mutant cells," Dr. Shukla says.
As predicted, BORIS depletion reduced the consumption of glucose in breast cancer cells. Inhibition of DNA methylation, too, decreased glucose uptake. Interestingly, BORIS depletion went beyond reduction in glucose consumption — it resulted in reduced cancer cell growth and cell viability.
"When BORIS is down regulated it affects alternative splicing of several genes which are associated with cancer hallmark (cancer growth, reduced apoptosis abnormal metabolism). So targeting BORIS will have a great impact for cancer therapy," says Smriti Singh from the Department of Biological Sciences, IISER, Bhopal, and the first author of the paper. "BORIS binds after DNA methylation. So we must determine whether inhibiting DNA methylation or BORIS is more effective in cancer therapy."

IIT teams use plant extract, heat to kill skin cancer cells

Nanoparticle formulation of a chlorophyll-rich biomolecular extract of an Indian medicinal plant Anthocephalus-cadamba combined with a near-infrared dye has been found to selectively kill skin cancer cells.
The plant extract is particularly toxic to cancer cells as there is enhanced generation of reactive oxygen species (ROS) while the dye aids in the destruction of cancer cells through photothermal therapy. Near-infrared light was used to heating up the nanoformulation.
The results were published in the International Journal of Biological Macromolecules.
Two teams from Indian Institute of Technology (IIT) Hyderabad and IIT Bombay working together have achieved promising results using skin cancer cell lines.
While the plant extract is hydrophobic and hence the uptake by cells will be less, the nanoformulation of the extract makes it less hydrophobic, thereby increasing the bioavailability significantly. The extract and the dye together are encapsulated in a FDA-approved polymer to produce the nanoformulation.
"Uptake of the nanoformulation is nearly the same by normal and cancerous cells. But the extract produces elevated levels of ROS only in cancerous cells. Right now we don't know the precise mechanism by which higher ROS is generated inside cancer cells," says Dr. Aravind Kumar Rengan from the Department of Biomedical Engineering at IIT Hyderabad and one of the corresponding authors of the paper. The levels of ROS inside normal cells were insignificant.
Unlike the highly selective nature of the extract, the photothermal ablation produced by the dye when exposed to near-infrared light is not selective. "So we have minimised the photo thermal effect and enhanced the selective toxicity by adding the plant extract. This way, we need to use minimal photothermal effect to kill cancer cells," Dr. Rengan says.

Synergestic effects

"We have been to achieve a synergistic effect by combining the natural extract and photothermal therapy. There was higher cell death when the combination was used than when photothermal therapy alone was used," says Prof. Rohit Srivastava from the Department of Biosciences and Bioengineering at IIT Bombay and the other corresponding author of the paper.
The NIR dye used (IR-780) for photothermal effect is an inherently imaging agent. The makes the use of any other chemical as an imaging agent redundant.
On being irradiated with near-infrared light, the dye gets heated up and facilitates the release of the extract from polymer membrane. After 4-5 minutes of irradiation, about 80% of cancer cells were killed. AFter irradiation, the temperature of nanoparticles that contained the dye and the extract increased to 51 degree C. Cells die when heated beyond 42 degree C.

"The nanoformulation with only the plant extract killed less than 20% skin cancer cells while the nanoformulation with only the dye killed 45-50% cells. But the extract and the dye used together killed 82-83% cancer cells," says TejaswiniAppidi from the Department of Biomedical Engineering at IIT Hyderabad and one of the first authors of the paper.

But the crude extract (not made into nanoformulation) killed 51% cancer cells at 20 microgram per ml concentration. "The reduced toxicity of the extract in nanoformulation was because only very little of the extract could come out of the polymer coating," says Appidi.

"We will be working on different kinds of breast cancer in animal models," says Deepak Pemmaraju from the Department of Biomedical Engineering at IIT Hyderabad and the first author of the paper. "At 780 nm, the penetration of IR will be less than 0.5 cm. The depth of penetration can be increased by using higher IR wavelength."

The use of nanoformulation containing both the extract and the dye will be particularly useful in treating resistant cancer cells.

"The extract that is released will suppress the growth of resistant cancer cells that escape the transient photothermal heat," says Dr. Rengan.

IIT Hyderabad uses activated jamun to remove fluoride from water

Now, while removing excess fluoride from drinking water, the usual problems such as high operational costs and getting rid of toxic sludge will be a thing of the past. Researchers at the Indian Institute of Technology (IIT) Hyderabad have used activated jamun seed powder to bring the fluoride content in drinking water to less than the WHO limit of 1.5 mg per litre. The results were published in the Journal of Environmental Chemical Engineering.

The team led by Dr. Chandra S. Sharma from the Department of Chemical Engineering at IIT Hyderabad mixed the jamun seed powder thoroughly with potassium hydroxide and heated it to 900 degree C for an hour to produce activated jamun powder. The activation increases the pore volume several times and the surface area by more than 50 times. As a result, the fluoride adsorption efficiency increased several times compared to samples that were not treated with KOH but heated to 900 degree C.

The fluoride ion removal increases with a decrease in pH, with maximum adsorption found at pH 3. The activated jamun seed acquires a positive charge at low pH and the positive charge attracts the fluoride ions while the negative charge in an alkaline medium repulses the fluoride ions.

With fluoride adsorption capacity of 3.65 milligram per gram, activated jamun seed was close to tea ash (3.75 milligram per gram) but much higher than other substances such as banana peel, coffee husk, and coconut shell.

"Besides testing the activated jamun seed powder in the lab we also tested it using groundwater taken from Nalgonda village, which is one of the worst fluoride-affected villages in India. After two hours of contact time, we were able to reduce the fluoride content from 3.2 milligram per litre to less than 1.5 milligram per litre, which is the WHO limit," says Dr. Sharma.

On heating the activated jamun powder to 50 degree C, the fluoride gets desorbed and the jamun powder can be reused up to five times. "About 96% of the fluoride can be desorbed. So there is a loss of only 4% efficiency after each desorption," he says.

Disposal of sludge

Disposal of the fluoride sludge is another area that the team is working on. "The fluoride ions desorbed from the activated carbon will be present in very small quantity of water. We can add sodium hydroxide to this water to produce sodium fluoride," he says. The major objective of the current study was to evaluate the fluoride removal efficiency using a novel, low-cost activated carbon.

"We will next be testing the efficiency of the activated jamun powder in water containing multiple ions such as fluoride, arsenic and heavy metals," says RamyaAraga the Department of Chemical Engineering at IIT Hyderabad and the first author of the paper.

"We have so far carried out all tests in batches. We need to now undertake column studies," says Araga. The continuous flow parameters have to be optimised to achieve best results; during the batch studies, two hours of contact time was needed for the fluoride to be removed.

Small molecule reverses antibiotic resistance

Using a small molecule screened from a synthetic library of 8,000 molecules, researchers at the Indian Institute of Technology (IIT) Roorkee have been able to reverse drug resistance and restore the efficacy of fluoroquinolone-group of antibiotics by inhibiting the proton gradient which drives the efflux pump. Antibiotic-resistant bacteria use the efflux pumps to expel antibiotics from the intracellular environment thus preventing antibiotics from reaching the target thus helping the bacteria to survive.

By inhibiting the proton gradient using the small molecule, the team led by Prof. RanjanaPathania from the Department of Biotechnology at IIT Roorkee was able to inactivate the efflux, leading to an effective build-up

of antibiotic inside the bacteria and subsequent bacterial death. The results were published in the International Journal of Antimicrobial Agents.

The team studied the efficiency of the small molecule in multidrug-resistant bacteria Acinetobacter baumannii. While the small molecule did not inhibit the growth of the bacteria per se, it was able to enhance the activity of a few antibiotics such as ciprofloxacin and norfloxacin in fluoroquinolone-resistant clinical isolates of A. baumannii. A. baumannii causes pneumonia, meningitis and urinary tract infections and is one of the most prevalent hospital-acquired infections across the world.

ESKAPE pathogen

"The reason for using small molecule to target A. baumannii is because it is among the six ESKAPE pathogens that cause the most hospital-acquired infections," says Atin Sharma from IIT Roorkee and one first author of the paper.

"Since the molecule inhibits the proton gradient, it and can potentially inhibit a wide variety of proton-driven efflux pumps in many multidrug-resistant pathogens," says Prof. Pathania.

They found that lower dosage of antibiotics were sufficient to kill the bacteria when used along with the small molecule. In the case of clinical isolates of A. baumannii, when 25 micromolar of the inhibitor was used along with the antibiotic, there was a 64-fold reduction in the minimum inhibitory concentration (MIC) (the lowest concentration of the compound required to inhibit the visible growth of a pathogen) of both ciprofloxacin and norfloxacin.

"The use of small molecule inhibitor not only restores the efficacy of antibiotics but also decreases the frequency of resistant bacteria," she says. Ciprofloxacin in combination with 50 micromolar of the inhibitor exhibited "significantly lower" mutation selection frequency compared with ciprofloxacin used alone at the same concentration.

The molecule appears safe to mammalian cells at minimum effective concentration of 16 micromolar and 32 micromolar for ciprofloxacin and norfloxacin respectively. The IC50 (a measure of toxicity) of the small molecule for human embryonic kidney cells is about 133 micromolar, which is about ten times more than the effective concentration.

"Most of the PMF [proton-motive force] inhibitors are associated with high toxicity. But the small molecule is not an inhibitor of PMF as it targets only the proton gradient and hence is not toxic to mammalian cells," says Prof. Pathania.

The molecule has also been tested in mice models for safety and efficacy. "We could revive the activity of ciprofloxacin and norfloxacin on mice model of A. baumannii," she says.

IACS develops hydrogel to remove toxic dyes and metal ions

Scientists from Indian Association for Cultivation of Sciences (IACS), Kolkata, have developed a new gel that can remove toxic organic dyes and metal ions from waste water. They found the hydrogel began absorbing various commonly used dyes within 15 minutes. The dyes tested were malachite green, congo red, brilliant blue and rhodomine B. In the case of metals, the hydrogel was able to considerably remove commonly found ones such as cobalt and nickel from industrial effluents in about six hours. Basic amino acids like leucine and phenylalanine were used to make the gel; the gel is biodegradable. It was stable at room temperature and remained as a gel for several months.

Effective treatment

The current methods used for treating wastewater — adsorption using activated carbon, chemical precipitation or electrochemical techniques — are largely ineffective due to incomplete removal or high energy requirements. In comparison, the new hydrogel-based material is able to remove the hazardous waste effectively as it has high water permeability, large surface area for adsorption and is also simple to use.

"We monitored the uptake capacity of the hydrogel using UV spectroscopy and found that within a few hours the gel absorbed the dyes and the waste water turned almost colourless. The hydrogel can absorb the wastes for up to 60 hours before reaching a saturation point. The gel was able to remove 78-92% of the dyes and more than 80% metals ions," explains Nibedita Nandi, research scholar at IACS and first author of the paper published in Peptide Science.

Reusable resource

"The hydrogel can be washed with sodium bicarbonate and ethyl acetate and reused. As the dyes and metal ions are soluble in water they get washed out from the gel and the hydrogel can be used for up to four cycles. It can be used by the industries for effective treatment before wastewater disposal," says Prof. Arindam Banerjee, senior professor at the Department of Biological Chemistry, IACS, and corresponding author of the paper.

The researchers say that the production of the gel can be scaled up to the desired volume for use in water treatment at industries.

Nano generators go wireless

Scientists from Clemson University, U.S. have developed a new tribolelectricnanogenerator that can generate over 2,000 volts just by tapping on it and also wirelessly transfer the energy produced to a nearby battery. The scientists say that this is the first time wireless transmission of electrical energy has been achieved. It is also the first time a triboelectric nanogenrator has been directly 3D printed from biodegradable materials.

The nanogenerator harvests mechanical energy and converts into electrical energy and transferred wirelessly over a distance of three metres to a storage device like capacitor or battery.

“We can install the nanogenerator at airports, sidewalks and place the battery on the nearby walls to store the energy. Because there are no wires involved, there is no need of power outlets and can be installed easily,” says Prof. Ramakrishna Podilla at the Laboratory of Nano-Biophysics and Clemson Nanomaterials Institute, Clemson University, Clemson, South Carolina, U.S.

These generators have a wide range of applications. They can be used to light up our homes, control doors and even set burglar alarms. The scientists are now working on developing fingerprint sensitive generators for home-security applications.

Generator set-up

The main component of the generator is polylactic acid, a plant derived polymer. Since polylactic acid has a high electrical resistance, the scientists incorporated graphene to improve the conductivity while retaining the polymers ability to be polarized.

“The generator is made of graphene-polylactic acid layer on the bottom and a Teflon layer on top. When these two materials with very different electro negativity come into contact, they produce large voltages. Just one hand tap is enough to produce current of 2000 volts,” explains Prof. Podilla who is corresponding author of the paper published in Advanced Energy Materials . The nanogenerator was capable of producing an instant peak power up to 70 milliWatts.

“The device produces electric fields at two unique frequencies. Using these frequencies, we custom built an inexpensive wireless signal processing circuit with an inbuilt filter. This will help avoid interference from the environment including WiFi routers, mobile phones, and AC power outlets,” Sai Sunil Kumar Mallineni, a graduate student at Clemson Nanomaterials Institute and first author of the paper published in Advanced Energy Materials says in an e-mail toTheHindu .

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COMPUTER & IT

NIIST team fabricates a wearable antenna

Wearable antenna embedded in a multilayered polyester fabric suitable for WiMAX (Worldwide Interoperability for Microwave Access) applications may soon become a reality, thanks to the work by researchers at the National Institute for Interdisciplinary Science and Technology (CSIR-NIIST), Thiruvananthapuram. The wearable WiMAX antenna, which is about 3 cm in length and nearly 4 cm in width, is flexible, light weight and operates at around 3.37 GHertz. Wearable antenna has applications in telemedicine, defence and environmental monitoring, among others.

"Our goal is to make wearable antenna which can be embedded in the jacket worn by soldiers in remote locations. We can connect the antenna to different sensors such as temperature, pressure and ECG sensors and the data can be transmitted to a remote server. The antenna can sense and communicate data in a non-intrusive manner. This way we can monitor the health of soldiers," says Dr. P. Mohanan from Cochin University of Science and Technology, Kochi and one of the authors of the paper.

Silver choice

Conventionally, thin copper films cladded to glass reinforced epoxy substrates are used for making patch antennas and these antennas are not flexible.

The antenna fabrication can be dramatically simplified by printing technology using copper ink where the radiating patch as well as bottom electrode can be screen printed onto flexible substrates including fabrics. But the use of copper ink is fraught with problems as it gets oxidised easily thus compromising the performance of the antenna.

Dr. K.P. Surendran from the Materials Science and Technology Division at NIIST and Roshni S. Babu overcame this problem by using a silver ink for printing the bottom electrode on the polyester fabric as well as the E-shaped patch antenna. Screen printing on fabric is not new but the challenging arises from the roughness of the fabric. "To overcome the problem of surface roughness, we coated the fabric with a polymer (polyvinyl butyral or PVB) to make the surface smooth and hydrophobic," says Dr. Surendran, who is the corresponding author of the paper published in the journal Smart Materials and Structures .

Coating the fabric with a PVC polymer reduced the surface roughness from 341 nanometre to about 15 nanometre. The polymer coating also made the surface water-repelling (hydrophobic). "We can increase the degree of hydrophobicity by coating another polymer that is more hydrophobic," he says. It is essential to make the fabric hydrophobic as wetting of the fabric compromises the performance of the antenna.

Thicker fabric

A thicker fabric base is an essential requirement for making a wearable antenna. The researchers achieved this by hot pressing three layers of the fabric with polyacrylate sheets in between the fabric layers; the polyacrylate sheet acted as an efficient adhesive. A thicker fabric prevents the ink from permeating during screen printing. "We were able to achieve over 1 mm thick fabric by gluing three layers of the fabric," he says.

A worn fabric undergoes a lot of flexing and bending and very often the performance of a wearable antenna gets affected after repeated bending and flexing. When the wearable antenna is bent, some of the electrical contacts between the metal ink particles on the patch and bottom electrode get disrupted thus reducing the radiation efficiency. The radiation efficiency becomes normal when the fabric is unbent.

"The radiation efficiency did not deteriorate even when bent for cycles of 10 up to 100 times," Dr. Surendran says.

Since the antenna radiates microwave, it is necessary to protect the body from the microwaves emitted by wearable antennas. "The bottom electrode protects the body from radiation. So wearable antennas are safe," assures Dr. Surendran.

The size of the antenna can be reduced by using an antenna array (many antenna printed in a symmetric fashion). "We have developed a prototype already but want to increase the hydrophobicity further," he says.

IIT Madras develops algorithms that learn like humans

It is known that DeepMind, the company which was acquired by Google, produced an algorithm called AlphaGo that beat the world's number one at the Go game. One of the methods behind the success of AlphaGo, called deep reinforcement learning, is being further developed by IIT Madras researchers to construct their own algorithm to play not just the Go game, but for more complex tasks.

What they build into the algorithm is not just learning, but learning from mistakes as well.

"There are two parts to engineering this – one involves incorporating features into the neural network that will get the program to recognize parts of the screen [when playing a game]. The other part involves making associations between utilities and action – for instance deciding whether to move left or right based on a specific pattern on the screen," explains Prof. B Ravindran who heads the Robert Bosch Centre for Data Science and Artificial Intelligence, at IIT Madras.

The team trained the algorithm using "experts" that were basically programs that had mastered a method of playing the game. Apart from this, the algorithm was also made to learn "from scratch" – that is, without the intervention of experts.

Not just this, the manner of learning mimics humans. For instance, humans don't change their strategy too fast, usually. So if the player [a bot or an algorithm] takes a left turn, it continues to do that for a predetermined time. This incorporated smoothness into the decision making. "When we came up with algorithms that incorporated this, we observed improvement by several thousand per cent in the learning performance," says Prof. Ravindran.

Squash to tennis

If a player knew how to play squash, can she use that knowledge to play tennis? This is known as transfer learning. Within this there are various things to contend with – selective transfer, which is, in the example of tennis, akin to learning the forehand of one player and the backhand of another player. This sort of hybrid-making can come of use when the machine learns from different "experts" with different skills.

Another ability built into the program was a tendency to avoid negative transfer. That is, if the "expert" that the program was learning from is actually bad at the game, the algorithm stops following this expert and chooses a different option – which may be following another expert or learning from scratch by itself. Prof. Ravindran explains by showing a graph in which relative performances of various programs that have been tutored with and without these features have been mapped out. The results clearly demonstrate the usefulness of incorporating the selective transfer and avoidance of negative transfers.

Having worked on the relatively simple arcade games , the team now plans to move on to more complex tasks involving higher-level skills. Humans operate at different levels of granularity in decision making, also we incorporate memory easily into learning. Can this be taught to machines?

They could be working on self-driving cars very soon: "We are planning to build in concepts of risk-awareness through deep reinforcement learning. To apply these ideas to robotics and, say, self-driving cars, there needs to be safety and risk-awareness built in. So we are working on this," he says.

Self-taught program beats humans at Go game

Researchers at DeepMind, a company that specialises in developing artificial intelligence, have succeeded in developing a program – AlphaGoZero – that can beat human players at the Go game. Now that itself does not sound new – it is well known that earlier versions of AlphaGo have beaten world champions at the game. What is new is that, using the method of deep reinforcement learning, the program has actually learnt the game all by itself – with no human inputs – from scratch, tabula rasa!

The Go game is a Chinese board game played on a checkerboard with 'stones' of two colours. The name translates into 'the encircling game' and the aim of each player would be to surround as much territory as possible.

The system starts with a neural network that knows nothing about the game. This plays against itself, combining the neural network with a search algorithm. The network is updated to predict the next move as well as the prospective winner. The updated neural network and the search algorithm are combined to produce a new version of AlphaGoZero. The process is then repeated to build better program at the end of each iteration.

Thus, in just a few days, over millions of games against itself, the program learnt the Go game from scratch. It was interesting that the game not only learnt human strategies but also gained new types of knowledge which were unconventional for humans.

After three hours of training, AlphaGoZero played like a human beginner foregoing long term advantages in favour of capturing as many stones as possible; after 19 hours it mastered advanced strategies such as life-and-death, influence and strategy; in 70 hours, it played at a superhuman level, with a game involving multiple challenges across the board.

Backgammon and Go

"It's a powerful method," says Professor B Ravindran, head of Robert Bosch Centre for Data Science and Artificial Intelligence, at IIT Madras, who was not involved in this research. He recalls that in the 1990s Gerald Tesauro, IBM Research, used reinforcement learning to master the backgammon game. "Go is several orders more complex. There was no player [AI] until the deep neural networks came in. The search technique is about

15 years old and in conjunction with the neural network it is powerful," he says.

While David Silver, corresponding author of the Nature paper, was unavailable to comment on the work, Demis Hassabis, co-founder and CEO, DeepMind, said in an email: "It's amazing to see just how far AlphaGo has come in only two years. AlphaGo Zero is now the strongest version of our program and shows how much progress we can make even with less computing power and zero use of human data. Ultimately we want to harness algorithmic breakthroughs like this to help solve all sorts of pressing real world problems like protein folding or designing new materials. If we can make the same progress on these problems that we have with AlphaGo, it has the potential to drive forward human understanding and positively impact all of our lives."

IIT Bombay makes low cost vibration sensors

Researchers at the Indian Institute of Technology (IIT) Bombay have successfully made low-cost piezo-resistive vibration sensors using polyurethane foam coated with carbon nanomaterial-based ink. These sensors can be used for monitoring the health of industrial machines and equipment and help identify incipient failures thereby enabling efficient maintenance schedule planning.

The ink is made of functionalised multi-walled nanotubes that are dispersed in a reduced graphene oxide matrix. It is conductive due to the presence of large number of multiwalled nanotubes. The ink, which uniformly coats the pores of the foam when dipped-coated, imparts piezo-resistive properties. Conductive sheets were pasted on the top and bottom sides of the foam and electrical wires connected to the sheets for measurements. The ink and sensor were developed at the Plastic Electronics and Energy Laboratory (PEEL), Department of Metallurgical Engineering and Material Science, IIT Bombay.

"When the PU foam coated with the ink is perturbed, in this case compressed, the air gaps are removed and the foam gets thinner. This provides a conduction path for electrical charges. The resistance drops as the foam is compressed and it becomes more conductive," says Amit Tewari at IITB-Monash Research Academy, IIT Bombay, and one of the authors of the paper published in the journal IEEE Sensors Letters. "The sensor is so sensitive that it can measure blood pulse."

"The total cost of materials required for making the sensors works out to less than Rs.200 per sensor, and can be reduced further if mass produced. The ink costs only about Rs.7 per sensor. No sophisticated equipment is required for fabricating the sensor," says Prof. Dipti Gupta from PEEL, IIT Bombay and one of the authors of the paper. In comparison, commercially available vibration sensors for such applications cost more than $50 per sensor, which makes it prohibitively expensive.

Characterisation

The team validated the suitability of the foam-based material as vibration sensors. The team was able to classify different machine operating conditions (good versus bad bearing, and good versus bad gearbox) based on vibration signals.

In the absence of a shaker table to characterise the vibration sensor, the researchers used a portable Phillips Bluetooth speaker. The foam sensor was rigidly mounted to the speaker and audio recordings were used to generate vibrations that were to be studied. Acoustic recordings for different machine operating conditions were played on the speaker and the sensor was validated.

Unlike a shaker table, speakers will not produce high amplitudes, so the team focussed on the frequency of the tones to validate the sensors. "Our interest was to locate the frequency of the excitation vibration signal," says SiddharthTallur, Department of Electrical Engineering, IIT Bombay, who is corresponding author of the paper. "We were looking for these tones in the sensor output."

Danger signs

To be able to identify the danger signs of a machine, the output of the vibration sensor has to be captured and the Fast Fourier Transform (FFT) has to be computed. One should then look where the peaks are located in the FFT. Since the vibration signal would vary from one gearbox to another, the vibration signal prior to failure can be identified only when data for each gearbox in its good state is available. It will then be possible to look for shifts in the frequency as the machine ages. One way to make the measurements independent of the variation in machines is by increasing the bandwidth studied. Another will be to look for variation in particular frequency bands than specific frequencies.

"In the real-world scenario, we will be using the sensors directly on the machines," Prof. Tallur says. "It is not clear how many sensors are needed per machine and the location of placement on the machines. If sensors are cheap we can deploy more sensors per machine. And this is where the low-cost of our sensors becomes particularly relevant."

"We are jointly working on developing more such novel improved sensors and exploring more application spaces as well as deployment and field testing of such sensors,"

he says.

Diagnosing early-stage cervical cancer using artificial intelligence

The morphology of healthy and precancerous cervical tissue sites are quite different, and light that gets scattered from these tissues varies accordingly. Yet, it is difficult to discern with naked eyes the subtle differences in the scattered light characteristics of normal and precancerous tissue. Now, an artificial intelligence-based algorithm developed by a team of researchers from Indian Institute of Science Education and Research (IISER) Kolkata and Indian Institute of Technology Kanpur makes this possible.

The algorithm developed by the team not only differentiates normal and precancerous tissue but also makes it possible to tell different stages of progression of the disease within a few minutes and with accuracy exceeding 95%. This becomes possible as the refractive index of the tissue is different in the case of healthy and precancerous cells, and this keeps varying as the disease progresses.

"The microstructure of normal tissue is uniform but as disease progresses the tissue microstructure becomes complex and different. Based on this correlation, we created a novel light scattering-based method to identify these unique microstructures for detecting cancer progression," says SabyasachiMukhopadhyay from IISER Kolkata and first author of a paper published in theJournal of Biomedical Optics.

Elaborating on this further, Prof. Prasanta K. Panigrahi from IISER Kolkata and corresponding author of the paper says: "The collagen network is more ordered in normal tissues but breaks down progressively as cancer progresses. This kind of change in tissue morphology can be picked up by light scattering." White light spectroscopy (340-800nm) was used for the study.

Statistical biomarker

The change in scattered light as disease progresses is marked by a change in tissue refractive index. The team has quantified the changes in tissue refractive index using a statistical biomarker — multifractal detrended fluctuation analysis (MFDFA). The statistical biomarker has two parameters (Hurst exponent and width of singularity spectrum) that help in quantifying the spectroscopy dataset.

While MFDFA provides quantification of light scattered from the tissues, artificial intelligence-based algorithms such as hidden Markov model (HMM) and support vector machine (SVM) help in discriminating the data and classifying healthy and different grades of cancer tissues.

"The classification of healthy and precancerous cells becomes robust by converting the information obtained from the scattered light into characteristic tissue-specific signature. The signature captures the variations in tissue morphology," says Prof. Panigrahi.

"The MFDFA-HMM integrated algorithm performed better than the MFDFA-SVM algorithm for detection of early-stage cancer," says Mukhopadhyay. "The algorithms were tested on in vitro cancer samples."

In vivo samples

The team is expanding the investigations to study in vivo samples for precancer detection. While the accuracy achieved using in vitro samples was over 95%, based on a study of a few in vivo samples the accuracy is over 90%.

"In the case of in vitro samples we were able to discriminate between grade 1 and grade 2 cancer," says Prof. Nirmalya Ghosh from IISER Kolkata and one of the authors of the paper. "More testing is needed using in vivo samples."

"Superficial cancers such as oral and cervical cancers can be studied using this technique. And by integrating it with an endoscopic probe that uses optical fibre to deliver white light and surrounding fibres to collect the scattered light we can study cancers inside the body," says Prof. Ghosh.

JNCASR adds more security to LiFi

Like WiFi, the light-fidelity (LiFi) technology that uses both visible and near-visible light is used for free-space communication. While microwaves used in WiFi technology to transmit signals can pass through walls, visible and near-visible light that carry the LiFi signal cannot, thus making the network more secure. Now, researchers from Bengaluru's Jawaharlal Nehru Centre for Advanced Scientific Research (JNCASR) have added another layer of security to LiFi.

Light bounces off from walls and falls on the receiver. So wall boundaries can be used effectively for reflecting signals so that communication is maintained even without line-of-sight communication between the signal source and receiver. Detectors can receive both direct and reflected signals. "There is no distortion when light bounces of walls but the signal can get attenuated. We can reduce the attenuation to some extent by using more light bulbs, keeping the walls reflective and having large receivers," says Prof. K.S. Narayan from the Molecular Electronics Lab at JNCASR who led the team of researchers.

So the researchers studied the effect of walls painted with fluorescent and phosphorescent paints. Both fluorescent and phosphorescent paints absorb and then emit light with marginal loss. "This leads to interesting possibilities," he says.

Jamming the signal

The researchers set out to do the complete opposite of what other researchers have been trying to do. White LED is obtained by combining blue LED with phosphors. While others have been trying to reduce the excitation life time of phosphors to improve the signal bandwidth, the JNCASR researchers purposely added phosphors to introduce noise in the signal to make the network more secure.

"While the fluorescent material absorbs and emits a photon before the next photon can fall on it, the time taken to emit is longer in the case of phosphorescent paint. The phosphorescent paint randomly emits photons, which ultimately scrambles the signal by superimposing a larger noise component to the signal," says AnaranyaGhorai from the Molecular Electronics Lab at JNCASR and first author of apaperpublishedin the Journal of Optics .

"The phosphorescent paint adds more noise to signal and in the process reduces the signal-bandwidth. This results in slower speeds. So we can selectively restrict the LiFi usage by choosing an area where distortion is needed by painting that part of the wall with phosphorescent paint," says Prof. Narayan. "The signal is corrupted by the noise and we can sort of jam the signals to inconvenience the user and even prevent usage."

Harnessing leftover light

On absorbing light, phosphorescent paint remains in an excited state and continues to emit light even several hours after the original source of light has been switched off.

"We can now use the light emitted by the phosphorescent paint as a source of signal by using an appropriate modulator," says Prof. Narayan. This would mean that signal transmission can continue for hours even when light source has been turned off. "This was not a targeted research. This idea just came about and we had some fun. But it has opened up an interesting area of research," says Prof. Narayan.

Platform created to connect Chinese hardware with Indian software

A new wave of Indian software developers will soon be able to plug into China's next wave of industrialisation, based on Artificial Intelligence and Internet of Things (IOT).

"Indian software developers face an existential threat if they don't shift to high-value domains such as Artificial Intelligence and IOT. Chinese companies specialising in hardware can be their perfect partners in moving up the value chain," said Gagan Sabharwal, senior director, National Association of Software and Services Companies (NASSCOM), in a conversation with a group of visiting Indian journalists.

Mr. Sabharwal pointed out that China's shift to Industry 4.0 will generate an explosive demand for IT-based automation. In turn, this would provide a major opportunity, especially for small and medium-sized Indian software companies, which possess cutting-edge technology, but are looking for suitable overseas partners for scaling up their product line.

"In our effort to connect India's strength in software and China's heft in hardware, we felt we need a hand-holding bridge. After considerable hard work, we seem to have achieved a breakthrough," he observed.

Consequently, NASSCOM and the local government in Dalian have set up the Sino-Indian Digital Collaboration Plaza (SIDCOP) — a "match-making" platform that will connect small and medium-sized Indian software developers, with Chinese companies specialising in hardware. Zeta-V Technology Solutions — a start-up with a local presence in Dalian — will operate the SIDCOP platform. SIDCOP will be located in the brand new NASSCOM IT corridor within Dalian BEST City — a dedicated business park on the outskirts of Dalian city, in northeast China.

Internet penetration in India set to surge, big opportunity for firms: Omidyar report

Increasing mobile-phone penetration and declining data costs will add 500 million new internet users in India over the five years, creating opportunities for new businesses to serve this demography, private equity and venture capital firm Omidyar Network said in report.

"Over the next five years, half a billion Internet users will come online using their smartphones, and therefore, it creates an opportunity for businesses and entrepreneurs that serve these segments. We are expecting a whole new breed of entrepreneurs who will cater to these new segments of people that will come online through their mobile phones," said RoopaKudva, partner and managing director, India, at Omidyar Network in an interview.

This "next half a billion" population will face barriers such as lower purchasing power, high data service costs, women's reticence in using the internet, lack of confidence to

transact online and paucity of local language content, the report said. According to Kudva, these barriers present an opportunity to create new businesses specific to this population segment.

"This is a frugal population that will require highly affordable data services and innovative approaches to building businesses that can both earn their trust and address their needs in a cost-effective way," said Kudva.

The initial wave of opportunity is in providing access to internet, providing new local social and communication apps and local language content which moves away from pure entertainment, she said.

Financial and healthcare services are other major opportunities. "Fintech clearly has completely opened up because of low cost payment infrastructure and availability of data. So a lot of fintech is coming up around use of alternate data for providing access to credit to poor," said Kudva.

Kudva added that the market in fintech is now going beyond payments into newer areas such as insurance and savings and investment products.

"Digital health is another area that will see a lot of action, whether it is remote diagnosis, or medical devices with IoT (Internet of things), analytics based businesses," she said.

The massive size of this new Internet user market is attracting not just impact investors but also traditional venture capital (VC) investors.

"The boundaries are blurring, because it is a large number and because there is potential to expand the market. Impact investors naturally have an inclination towards this consumer segment, and so, initially you will see them investing more," she said.

However, she added that in the last two years, the traditional VCs have also been looking at this market, as far as going down the income pyramid is concerned, particularly for urban population. "It is not the exclusive domain of impact investors," Kudva added.

Monetization of these opportunities, however, is still some time away.

"I think these applications are a long way off from monetization at this point, especially the social and communication applications. At this point, entrepreneurs are focusing on getting customers online and making them comfortable to use these apps. Today, a lot of these businesses are value-based on the number of customers they have," said Kudva.

Watch out for ransomware in 2018: report

Ransomware attacks in cyberspace are likely to increase and become more sophisticated in 2018, targeting high net worth individuals and corporates, the cybersecurity giant McAfee Inc. warned in its latest prediction report.

The report also warns individual home users that greater inter-connected home devices will surrender consumer privacy to corporates.

"The profitability of traditional ransomware campaigns will continue to decline as vendor defences, user education, and industry strategies improve to counter them. Attackers will adjust to target less traditional, more profitable ransomware targets, including high net-worth individuals, connected devices, and businesses," the McAfee Labs 2018 Threats Predictions Report stated.

Cyber saboatge

The report, which identified five key trends to watch next year, said the pivot from the traditional would see ransomware technologies applied beyond the objective of extortion of individuals, to cybersabotage and disruption of organisations.

2017 witnessed a major explosion in ransomware attacks such as the 'WannaCry' epidemic in which attackers limit user access to their own systems till a certain ransom is paid to unlock them.

"The evolution of ransomware in 2017 should remind us of how aggressively a threat can reinvent itself as attackers dramatically innovate and adjust to the successful efforts of defenders," said Steve Grobman, chief technology officer for McAfee in a statement.

'Arms race'

Mr. Grobman said there was an 'arms race' between attackers and defenders, and "human intelligence amplified by technology will be the winning factor".

As consumers increasingly network their homes, the report warns that connected home device manufacturers and service providers will seek to overcome "thin profit margins by gathering more of our personal data — with or without our agreement —turning the home into a corporate store front".

"Corporate marketers will have powerful incentives to observe consumer behaviour to understand the buying needs and preferences of the device owners," the report said.

Many cyber-crime cases not investigated

More than 12,000 incidents of cybercrime were reported in 2016, but nearly the same number of such crimes carried forward from the previous years had not been investigated, the data released by the National Crime Records Bureau (NCRB) said.

In 2016, 12,317 such incidents were reported and in 2015 the figure stood at 11,592, a jump of 6.3%.

Only in 30% cases reported in 2016, the police or the investigating agency filed a chargesheet. In absolute numbers, 7,990 persons were arrested for the crimes, which included 147 women and charge sheets were filed against 4,913 accused.

Illegal gain (5,987 incidents) and revenge (1,056) were the two top motives that accounted for cybercrimes. Sexual exploitation (686), insulting the modesty of women (569) and causing disrepute (448) constituted 13% of the crimes.

There were 40 cases that were done with a "political" motive and 14 cases pertained to sale and purchase of illegal drugs. There were 149 cases of inciting crimes against a community and three cases of inciting hate crimes against the country.

Of the 829 persons arrested for transmission of obscene and sexually explicit content, chargesheets were filed only against 484.

Uttar Pradesh with 2,639 cases reported the highest number of incidents accounting for 21.4%, followed by Maharashtra with 2,380, Karnataka 1,101 and Rajasthan 941 cases. There were 6,818 cases registered under various sections of the Information Technology Act that pertains to sending offensive and false information.

Crimes against state

Tamil Nadu topped the list when it came to booking people for committing crimes against the state, which includes cases of sedition. Of the 6,986 cases registered in 2016, 1,827 or 26% cases were reported from Tamil Nadu, followed by U.P. 1,414, Haryana 1,286 and Assam 343 cases. While 35 cases of sedition were reported in 2016, there were 31 cases related to imputation and assertions prejudicial to national integration.

Under the Official Secrets Act, 30 cases were reported and 922 cases were registered under the Unlawful Activities (Prevention) Act. In 2016, the police across India were investigating 12,637 cases of crimes against the State, of this 5,651 had been pending since 2015.

Meghalaya with 42 cases registered the most number of cases under Sections pertaining to sedition and waging war against the country.

Sushma, Doval speak on cybersecurity

The Union Minister for External Affairs SushmaSwaraj stressed that it is imperative states engage with each other diplomatically in response to increasing instances of cyberattacks to "diffuse tensions arising in the wake of challenges of attribution".

"The growing significance of cyber issues is reflected in the growing conversations across the world at all high-level summits, interactions and conferences," the Minister said at the closing ceremony of the two-day Global Conference on Cyber Space held here.

She pointed out that the issues of sovereignty among the states, data access, data jurisdiction, the growing threat of militarisation of cyberspace, cyber espionage, cyber weapons, and the applicability of international law in cyberspace, are some of the issues that require concerted diplomatic attention.

"The lack of borders in cyberspace and the anonymity of the actors has ensured that the traditional concepts of sovereignty, jurisdiction and privacy are challenged," Ms. Swaraj said.

Earlier in the day, during a panel discussion National Security Advisor (NSA) AjitDoval said, "…there is a need for new jurisprudence…the problem of attribution…in the court of law may be very difficult," Mr. Doval said. "The world will have to think [about] whether there is a need of a very specific regime dealing with the threats… first of all, there needs to be a consensus from all the states, the private sector, the stakeholders, the academia, the media ..everyone is a stakeholder, but the private sector has a major role and the states have a major role."

IIT Madras develops algorithms that learn likehumans

It is known that DeepMind, the company which was acquired by Google, produced an algorithm called AlphaGo that beat the world's number one at the Go game. One of the methods behind the success of AlphaGo, called deep reinforcement learning, is being further developed by IIT Madras researchers to construct their own algorithm to play not just the Go game, but for more complex tasks.

What they build into the algorithm is not just learning, but learning from mistakes as well.

"There are two parts to engineering this – one involves incorporating features into the neural network that will get the program to recognize parts of the screen [when playing a game]. The other part involves making associations between utilities and action – for instance deciding whether to move left or right based on a specific pattern on the screen," explains Prof. B Ravindran who heads the Robert Bosch Centre for Data Science and Artificial Intelligence, at IIT Madras.

The team trained the algorithm using "experts" that were basically programs that had mastered a method of play-

ing the game. Apart from this, the algorithm was also made to learn "from scratch" – that is, without the intervention of experts.

Not just this, the manner of learning mimics humans. For instance, humans don't change their strategy too fast, usually. So if the player [a bot or an algorithm] takes a left turn, it continues to do that for a predetermined time. This incorporated smoothness into the decision making. "When we came up with algorithms that incorporated this, we observed improvement by several thousand per cent in the learning performance," says Prof. Ravindran.

Squash to tennis

If a player knew how to play squash, can she use that knowledge to play tennis? This is known as transfer learning. Within this there are various things to contend with – selective transfer, which is, in the example of tennis, akin to learning the forehand of one player and the backhand of another player. This sort of hybrid-making can come of use when the machine learns from different "experts" with different skills.

Another ability built into the program was a tendency to avoid negative transfer. That is, if the "expert" that the program was learning from is actually bad at the game, the algorithm stops following this expert and chooses a different option – which may be following another expert or learning from scratch by itself. Prof. Ravindran explains by showing a graph in which relative performances of various programs that have been tutored with and without these features have been mapped out. The results clearly demonstrate the usefulness of incorporating the selective transfer and avoidance of negative transfers.

Having worked on the relatively simple arcade games , the team now plans to move on to more complex tasks involving higher-level skills. Humans operate at different levels of granularity in decision making, also we incorporate memory easily into learning. Can this be taught to machines?

They could be working on self-driving cars very soon: "We are planning to build in concepts of risk-awareness through deep reinforcement learning. To apply these ideas to robotics and, say, self-driving cars, there needs to be safety and risk-awareness built in. So we are working on this," he says.

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DEFENCE

Mitra Shakti 2017: India-Sri Lanka Joint Military Exercise

The 5th India-Sri Lanka joint training exercise "Mitra Shakti 2017" was held Aundh Military Station in Pune, Maharashtra. The two weeks exercise (October 13 and 25) is based on Counter Terrorist Operations (CTO) and Infantry company from both countries are participating in it.

Mitra Shakti 2017

The aim of joint training is to exchange best of military practices of two countries and build strong military-to-military (M2M) relation between two armies. It also aims at developing joint strategies by sharing the expertise of conducting operations, especially in counter-insurgency and counter terrorism (CI and CT) environment under UN mandate. The training module of exercise will include weapons training, basic military tactics and complex battle strategies.

INS Satpura, Kadmatt participates in Passage Exercise in Japan

Indian Naval Ships Satpura and Kadmatt participated in Passage Exercise (PASSEX) with Japanese Marine Self Defence Force (JMSDF) held at Sasebo, Japan. These ships are participating in the exercise in pursuance of India's Act East Policy and demonstration of India's commitment to peace and stability in Indo-Pacific Region. The visiting Indian Naval ships engaged with JMSDF in formal calls and also professional, social and sporting interactions.

Naval ties between India and Japan have reached new heights with bilateral and multilateral exercises since first 'Navy to Navy Staff Talks' between two nations in November 2008. Since then, naval ties have enhanced to cooperation in information sharing, meteorology and oceanography, disaster management and military training.

The defence and security interaction also expanded to encompass Defence Policy Dialogue and a Maritime Affairs Dialogue. Regular bilateral and multilateral maritime exercises are foundation for strong naval relations between both countries. The erstwhile Japan–India Maritime Exercise (JIMEX) led to Japan participating in 'MALABAR' exercise (a tripartite naval exercise between India, US and Japan) since 2014.

Defence Ministry to raise three new tri-service agencies

Ministry of Defence (MoD) is expecting to raise three new tri-service agencies in field of cyber warfare, space and special operations shortly. The proposal is with the other ministries of government for approval as the resources for them have to come from accretion and not under save-and-raise.

In 2012, the Chiefs of Staff Committee had recommended creation of three joint commands in the areas of cyber, space and special operations due to their increased relevance in modern warfare. Besides, the new joint military doctrine, released earlier in 2017 also underscores the need to prepare defence forces for emerging triad of space, cyberspace and special operations for future combat.

Key Facts

The new tri-service agencies are Defence Cyber Agency, Defence Space Agency and a Special Operations Division. These agencies will be headed by officers of rank of Major General and equivalent in Navy and Indian Air Force

The cyber and space agencies will be based out of Delhi, for close coordination with their civilian counterparts, while Special Operations Division will be based outside national capital.

Defence Cyber Agency: It will work in close coordination with National Cyber Security Advisor. It will focus on non-civilian cyber issues, including safeguarding critical infrastructure. It will be have over 1,000 personnel and will be distributed to various formations of Army, Navy and IAF.

Defence Space Agency: It will work closely with ISRO and DRDO for better utilisation and integration of space resources. This includes information sharing from individual satellites, and surveillance from other satellites which can then be shared with the concerned defence service. It will have over 200 personnel.

Special Operations Division: It will have components of Special Forces of Army, Navy and IAF, and will be equipped and trained together for various external contingencies. This division, which will be based at a location which already has training infrastructure, will have two SF battalions at its core, along with teams from Marcos and Garud.

INS Kiltan commissioned into Indian Navy in Visakhapatnam

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Indigenously-built anti-submarine warfare stealth corvette INS Kiltan was commissioned an into the Indian Navy at the Eastern Naval Command (Naval Dockyard) in Visakhapatnam, Andhra Pradesh

It is India's first major warship to have a superstructure of carbon fibre composite material resulting in improved stealth features, lower top weight and maintenance costs. About 81% of the ship is indigenous and it is well equipped to fight in Nuclear, Biological and Chemical (NBC) warfare conditions.

INS Kiltan

INS Kiltan is third of four Kamorta-class corvettes being built under Project 28. It is latest indigenous warship after Shivalik Class, Kolkata Class and sister ships INS Kamorta and INS Kadmatt of Indian Navy's arsenal. It is also first major warship to have undertaken sea trials of all major weapons and sensors as a pilot project.

The stealth corvette derives its name from one of islands in Aminidivi group of strategically located Lakshadweep and Minicoy group of islands. It has been designed indigenously by Indian Navy's in-house body Directorate of Naval Design under Project 28 (Kamorta Class).

Features: It is 109 meters in length and 14 meters at beam and is propelled by four diesel engines to achieve speeds in excess of 25 knots with an endurance of 3450 nautical miles. It has displacement capacity of 3500 tonnes and has installed propulsion and auxiliary systems that provides very low radiated underwater noise feature, required for anti-submarine warfare.

Stealth features: Enhanced stealth features of the ship have been achieved by 'X' form of Hull, full beam superstructure, inclined ship sides and use of Infra-Red Signature Suppression (IRSS) system designed by NSTL for cooling the Engine and Generator exhausts.

Weapons and Sensors suite: The ship hosts predominantly indigenous cutting-edge weapons and sensors suite which includes heavyweight torpedoes, ASW rockets, missile decoy rockets (Chaff), advanced Electronic Support Measure system, 76 mm calibre Medium Range gun and two multi-barrel 30 mm guns as close-in-weapon system (CIWS) with dedicated fire control systems, most advanced bow mounted sonar and air surveillance radar Revathi. In future, it will be installed with short range SAM system and carry an integral ASW helicopter.

Historical Legacy: The ship also boasts of proud legacy of the erstwhile Petya Class ship of same name 'Kiltan (P79)' built in the USSR which had actively participated as Task Force Commander in 'Operation Trident' during 1971 India-Pakistan war.

4th ASEAN Defence Ministers' Meeting-Plus to be held in Philippines

The fourth edition of ASEAN Defence Ministers' Meeting (ADMM)-Plus will be held in Philippines. India will be represented by Union Defence Minister Nirmala Sitharaman. It is her first foreign visit as Defence Minister.

Key Facts

The ADMM Plus meeting is expected to discuss ways to enhance defence and security co-operation among the member nations to effectively counter various transnational security challenges facing the region. It is also likely to discuss enhancing maritime security cooperation among the member countries. It will also deliberate extensively on the situation in Afghanistan and Syria besides China's growing military presence in the disputed South China Sea.

INDRA 2017: First tri-services military exercise between India-Russia begins

The first tri-service armed Forces (Army, Navy, & Air Force) exercise INDRA 2017 between India and Russia began at the 249th Combined Army Range Sergeevisky and in Sea of Japan near Vladivostok. It is overall 10th edition of INDRA exercise and India's first bilateral military exercise with any country involving all three services.

INDRA 2017

The scope of 11-day exercise includes professional interactions, establishment of joint command and control structures between Indian and Russian forces and elimination of terrorist threat in multinational environment under UN mandate.

The Indian contingent comprises 350 personnel from Army, 80 from Air Force, two IL 76 aircraft and one frigate and corvette each from the Navy. Russia is represented by approximately 1000 troops of 5th Army, marines and ships of Pacific Fleet and aircraft from Eastern Military District.

All-women crew of NavikaSagarParikrama expedition reaches Fremantle

INSV Tarini carrying all-women crew members of NavikaSagarParikrama, India's first ever circumnavigation expedition of globe by all-women crew entered west Australian port of Fremantle.

It is first stop over of INSV Tarini since the expedition was

flagged off by Defence Minister Nirmala Sitharaman in Goa in September 2017. So far, the vessel has covered 4,800 nautical miles from Goa, crossing Equator and Tropic of Capricorn.

Sri Lankan Coast Guard commissions OPV SURAKSHA gifted by India

Sri Lankan Coast Guard has commissioned Offshore Patrol Vessel (OPV) SURAKSHA gifted by India at Colombo port. It is first OPV of Sri Lankan Coast Guard.

Sri Lankan Coast Guard Ship (SLCGS) Suraksha earlier belonged to Indian Coast Guard (ICG) and was known as Varuna. It was officially handed over to Sri Lanka Navy at ceremony held at Kochi Port in India in September 2017.

Smart Anti Airfield Weapon: DRDO successfully tests light weight glide bomb

The Defence Research and Development Organisation (DRDO) has successfully tested indigenously developed light weight glide bomb Smart Anti Airfield Weapon (SAAW).

Total of three tests with different release conditions and ranges were conducted at Chandipur in Odisha and were all successful. The bomb was fired from an air force aircraft and was guided through precision navigation system. It reached the targets at greater than 70 km range, with high accuracies.

Goa Maritime Conclave (GMC)

Indian Navy had hosted Navy and Maritime Chiefs of 10 countries of IOR at first GMC to identify common threats in region and evolve a mechanism on how to tackle them. It aimed to bring together like minded nations to evolve and formulate collective responses to emerging challenges in maritime domain.

It was aimed at "Addressing Regional Maritime Challenges". The deliberations in it focused on emerging maritime threats and force structuring, maritime domain awareness, maritime security architecture, and maritime security challenges in IOR.

IMBAX 2017: India-Myanmar joint Army exercise begins in Meghalaya

The first India-Myanmar Bilateral Military Exercise 2017 (IMBAX 2017) was held at Joint Warfare Centre at the Umroi Joint Training Node in Meghalaya.\

It is first of its kind military training exercise between India and Myanmar on United Nations Peacekeeping Operations (UNPKO). It was conducted by Army's RED HORNS DIVISION under aegis of GAJRAJ CORPS.

DANX-17: Defence of Andaman & Nicobar Islands Exercise concludes

The Defence of Andaman and Nicobar Islands Exercise (DANX-2017) was conducted under aegis of Andaman & Nicobar Command from 20 to 24 November 2017.

The main objective of the five day exercise was to practice and validate procedures and drills of all Command forces aimed at defending strategic Andaman & Nicobar Islands.

Key Facts

Accretional forces from mainland including fighters, Special Forces, Naval ships and heavy lift transport aircraft participated in exercise. They collectively conducted fighter operations, night-para jumps at sea, slithering of troops from helicopters and amphibious landings of troops by ships. The purpose of the exercise was for adopting planning and precise execution of Command plans by forces in synergistic manner. It also aimed for being fully prepared for any eventuality in future.

BrahMos cruise missile successfully test-fired from Sukhoi-30 MKI for first time

The world's fastest supersonic cruise missile BrahMos was successfully test fired from Indian Air Force's (IAF) Sukhoi-30MKI fighter jet for the first time.

The missile was gravity dropped from Su-30MKI from its fuselage and two-stage missile's engine fired up and was propelled towards the intended target in Bay of Bengal.

Significance

It was for first time that missile was successfully tested from fighter aircraft against sea-based target. It makes IAF first air force in world to have successfully fire air-launched 2.8 Mach surface attack missile of this category. This test effectively gives Indian armed forces especially IAF ability to fire Brahmos Air Launched Cruise Missile (ALCM). With this, India also created world record and completed Supersonic Cruise Missile Triad by successfully test firing of Brahmos from IAF Sukhoi-30MKI fighter aircraft.

BrahMos cruise missile

The Brahmos is supersonic cruise missile developed by joint-venture between Russia's Mashinostroyenia and India's Defence Research and Development Organisation (DRDO). It operates on 'fire and forget principal' and is capable of being launched from land, sea, sub-sea and air against sea and land targets.

It is capable of carrying warhead of 300 kilogram (both

conventional as well as nuclear) and has top supersonic speed of Mach 2.8 to 3 (roughly three times speed of sound). It is two-stage missile, the first one being solid and the second one ramjet liquid propellant.
It is hailed as the world's fastest anti-ship cruise missile in operation. Its range was extended 600-km plus and capability to strike the targets with pinpoint accuracy after India became member of Missile Technology Control Regime (MTCR) in 2016. The Indian Navy and Army already operate different variants of Brahmos missile.

INS Kalvari: First Scorpene-class submarines inducted in Indian Navy
Prime Minister Narendra Modi has commissioned scorpene-class submarine INS Kalvari into the Indian Navy in Mumbai, Maharashtra. It is first of the six Scorpene-class submarines built under the strategic Project 75 built by Mazagon Dock Limited (MDL) with assistance and technology transfer from France's DCNS. The commissioning comes days after Indian Navy observed the golden jubilee of its submarine wing.
INS Kalvari will be the first conventional submarine to be inducted into India Navy after more than 17 years. INS Sindhushastra was last inducted conventional di**esel-electri**c submarine in July 2000 which was procured from Russia.
INS Kalvari
INS Kalvari is most modern non-nuclear stealth submarine in India Navy. 'Kalvari' is Malayalam word that means deep-sea tiger shark. It reflects its agility, strength and predatory prowess. The length of INS Kalvari is 67.5 metres and height of 12.3 metres and weighs 1,565-tonn and displacement capacity of 1,600 tonnes.
It is powered by two 1250 kW MAN extremely silent diesel-electric diesel engines making it very difficult to detect underwater. It boasts highly advanced Combat Management System and a sophisticated Integrated Platform Management System.
Its hull form, fin and hydroplanes are specifically designed to produce minimum underwater resistance. It has 360 battery cells (each weighing 750 kg) to power the extremely silent Permanently Magnetised Propulsion Motor. Its stealth capability is enhanced through mounting of equipment inside pressure hull on shock absorbing cradles.
Submarine Tactical Integrated Combat System (SUBTICS) suite is heart of INS Kalvari's weapons system which processes information from sonars on-board submarine in detecting targets which can then be engaged with torpedoes or missiles.
It is armed with heavy weight torpedoes and Exocet anti-ship missiles. It can launch torpedoes both while submerged or on the surface. It has an attack-and-search periscope equipped with infrared and low light level cameras and laser range finders to spot targets on the surface of the sea.
It is designed to operate in all theatres, including the tropics and can undertake multifarious types of missions typically undertaken by any modern submarine such as anti-submarine warfare, anti-surface warfare, intelligence gathering, area surveillance, mine laying etc.

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MISCELLANEOUS

Super smell strength of solitary bees

Thanks to olfactory receptors, certain food smells can make the mouth water. The small membrane proteins in the nose send signals to your brain about smell. But in bees, smell is not just associated with food or finding flowers but is also an important factor for survival and communication with mating partners (nest-mates).

To get a better understanding of these scent cues, scientists from the National Centre for Biological Sciences (NCBS), Bengaluru found solitary bees have over 100 olfactory receptors to help them perceive different smells. The results were recently published in Scientific Reports.

Odour signature

Solitary bees are different from honey bees. Most of the bee populations are solitary and these wild bees are responsible for pollination of up to 80% of flowering plants. Tomatoes, brinjal, blueberries and cranberries are mostly pollinated by these solitary bees. With almost 40% of the human kept honey bees dying each year scientists have started studying solitary bees as a positive alternative.

"It is important to identify and study the olfactory receptors as bees mainly depend on scent cues. They have an excellent memory and can identify and remember the smell of their preferred food plants. Social bees, like honey bees use many different odours (pheromones) to communicate among each other. There are about 10-12 different pheromones with different messages," explains Dr. Axel Brockmann, scientist at NCBS and one of the authors of the paper.

For example, scents like cuticular hydrocarbons help identify members of the same nest whereas the queen mandibular gland pheromones are important for the social integrity of the colony. "Bees are capable of producing alarm pheromones. When the nest is under some threat, the workers produce a scent to warn or recruit nest-mates for a defence," he adds.

Computational analysis

The scientists identified the olfactory receptors by using a new bioinformatics pipeline to compare social and solitary bees. "We found over 40 new olfactory receptors from each of the sequenced genomes in the two solitary bees. The previous annotation on solitary bees missed a whole chunk of data regarding their olfactory genes," explains Snehal D Karpe, research scholar at NCBS and first author of the paper.

The solitary bee Dufoureanovaeangliae has 112 olfactory receptors, while Habropodalaboriosa , another solitary bee, has a high number of 151. Previous analysis has shown that the social honey bees possess approximately 180 olfactory receptors. They examined if there is a higher demand for olfactory receptors in social bees and found that there is no consistent increase in number of olfactory receptors from solitary bees to social bees.i

In addition, they found a group of candidate olfactory receptors responding to queen mandibular gland pheromones which was expanded in honey bees, but not in solitary bees. This may be due to the fact that solitary bees do not have a queen. Also the putative floral scent receptors were found to be enriched in honey bees visiting multiple kinds of flowers than the specialist solitary bees which visit only one kind of flowers.

"Due to the large range of olfactory receptors, detailed functional characterisation of genes remains difficult. Such a bioinformatics overview and comparison provide excellent opportunities to observe interesting differences amongst honeybees and solitary bees. Such comparisons could have implications in our understanding of aberrations in human social behaviour too." says R. Sowdhamini, scientist at NCBS and corresponding author of the paper.

Biology in space and on Earth: Studies on the ISS

"Around the World in Eighty Days" was the famous 1873 novel by the French writer Jules Verne. It was a challenge then. A century and half later, anyone can do this within 80 hours, on an airplane. We can now go around half the world (say, from India to California) in 20 hours. That of course upsets our body clock. What is daytime here is night time there, and it takes a day or two to adjust our daily rhythm. The biological mechanism behind such daily rhythms (not just of people but even of plants) has been understood, and this fetched this year's Nobel Prize for three scientists.

"Fly me to the moon, let me play among the stars, let me see what spring is like, on Jupiter and Mars" sang Frank Sinatra sixty years ago. The Verne challenge has moved from Earth to the sky and the stars. And it appears, soon enough, it will be possible for anyone to be an astronaut. There are already companies that offer space trips to people. And when that becomes commonplace, what are all the biological changes that occur to life forms, how they adapt to the altered environment and recover once

they return to Earth – these are issues that are being actively studied today.

Two sets of projects are going on in this connection. One set is to keep humans in space for extended periods of time (months or years), study them there and again after they return home to earth. The International Space Station (ISS) was launched in 1998 at an altitude of 408 km above the Earth, and its residents experience near zero gravity. What happens to their bodies, organs, blood flow and other biological features is the major study here.

Space microbiology

The other set of experiments going on involves launching cells (single cell organisms such as bacteria) into space and studying their properties there, and comparing them with 'controls' on earth. This branch is now termed as space microbiology. Studying cells gives us a fundamental idea about what happens at the molecular level, and this will help in extending it further to tissues, organs and the whole organism itself – from the micro to the macro.

The latest report in space microbiology comes from the group of Dr Luis Zea of the University of Colorado in the US (Zea et al, Frontiers in Microbiology 2017; 8: 1598. doi:10.3389/fmicb.2017.01598). They sent one set of the bacterium E. colisamples to the ISS and had an astronaut there study its size, shape, response to the killer drug gentamycin, and other properties. The control set of E coli was studied at Colorado on earth, and the properties of the two sets compared. Such comparison ought to throw light on the effects of gravity on various aspects of cell biology.

The comparison is informative. First, the cells in ISS changed their shape, shrunk in size, the cell walls became thicker, coated with a film (called biofilm), and produced more spherical buds on their outer membranes than the controls on earth. These buds, called the outer membrane vesicles, enable bacterial survival during stress conditions. E coli in ISS were more drug-resistant than the controls on earth. It appears that the absence of gravity, which helps in transporting and pushing fluids 'downstream', the major mechanism of fluid movement, appears to be just diffusion, which is less efficient.

Experiments needed

Two other points also came out of this study. First, there may be a greater risk of infection in astronauts (or greater doses of the drug), and second, the endogenous microbes that live in the guts of astronauts, helping their metabolic activities, might become less efficient. More experiments are needed to ascertain these possibilities.

Turning now to real humans circling the earth on ISS. Experiments reveal that the viscosity of their blood increases, circulation decreases and the cardiovascular system becomes "lazy", or slows down a bit. The eyeballs become a bit oblong. Bones become thinner and organs like the liver 'shift" a bit. All these have been explained as due to the near-absence of gravity. These results are of value when we send manned space ships to other planets. What happens when they return to Mother Earth after such space trips – do they recover? The answer appears to be "yes", since astronauts who returned home after a long stay at ISS, recovering well with time. This is gratifying to note; recall the astronaut Sunita Williams actually ran a marathon back on earth, after a period of stay in space.

What about the biochemistry, cell biology and gene biology of astronauts? Do they differ from those of their earthbound brothers? The answer will come soon, once the ongoing, exciting identical twin study is over. Scott Kelly is a spaceman at ISS, while his identical twin Mark Kelly (a retired officer) stayed back on earth. Researchers have taken biological samples from each twin, before, during and after Scott's space mission (lasting 340 days at ISS). Is there a "space gene" that operates while in space, and goes silent back on earth? The study is ongoing and we await the results with excitement.

The Nobel and the Ig Nobel Prizes

The Nobel Prizes are world-renowned. The announcement of the yearly Nobel Awards is looked forward to every October. Each awardee has done something that has improved our knowledge in the field through his/her ideas and incentives. His or her work has brought benefits to our knowledge. No wonder a Nobelist is regarded with high esteem.

But recall that for every Shakespeare there is also a P.G. Wodehouse, whom we enjoy just as much. For every Picasso there is an M.C. Escher, and for every M.F. Husain there is an R.K. Laxman. Life is not always a serious affair, there is lightness, humour and nonsense, too, and we enjoy them as well. For every stuffed shirt there is a T-shirt as well!

This is true in science, technology and other fields of knowledge as well. This point is highlighted every year, also around October, by the awarding of what has been named as the Ig Nobel Prizes in various fields. These are awarded to "honor achievement that first make people laugh, and them make than think." The word Ig Nobel is a play on words and a parody of the Nobel, and borrowed from the word ignoble meaning "inferior."

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That the Ig Nobel Prizes were started by scientists way back in 1991 shows that scientists too have a sense of satire, sarcasm, humour and yet appreciation. The Ig Nobel prizes are chosen by a jury and are presented yearly actually by a Nobel Awardee, adding to the satire and value of the prize. (Actually two Nobelists, Sir Andre Geim of graphite fame and Dr. Roy Glauber of quantum optics fame, were themselves winners of Ig Nobel Prizes in 2000 and 2002 as well.)

To date, over 250 Ig Nobels have been awarded in fields as wide as science, literature, economics, peace, psychology and so forth. Readers will enjoy looking at the list of winners by going to https://en.wikipedia.org/wiki/**List_of_Ig_Nobel_Prize_winners**.

The contributions of many Ig Nobelists are serious and professional in approach, yet ones that make you laugh. For example, the Physics Prize for 2017 went to the paper by Dr. M. Farbin of France who studied the rheology (the study of the flow of matter) of cats and concluded that a cat can be a liquid (fluid enough to fit itself inside a beer mug), or a solid (shrink itself into a tight solid-like glob when immersed in a bath tub).

The Ig Nobel 2013 for Peace went to Mr. A. Lukashenko, the President of Belarus for making it illegal to applaud in public, and to the Belarus State Police for arresting a one-armed man for applauding. You will agree that this is well deserved. Likewise, the 2003 Ig Nobel in Economics was offered to the Vatican for outsourcing prayers to India!

Read www.nytimes.com/2014/06/13/world/short-on-priests-us-catholic-outsource-prayers-to-Indian-clergy.html.

Ig Nobel winners from India

While no Nobel Prize has gone to an Indian citizen after Amartya Sen's 1998 Nobel Prize in Economics (The 2009 Nobelist in Chemistry, the Indian-born Dr. Venki Ramakrishnan, is an American-British citizen), Ig Nobel Prizes have gone to at least 5 Indian citizens, working in India.

The 2001 Ig Nobel in Public Health went to Dr. Chittaranjan Andrade and Dr. B.S. Srihari of NIMHANS, Bengaluru for their path-breaking discovery (published in J. Clin. Psychiat. 62: 426-31, 2001), which suggested that rhinotillexomania (nose picking, in common parlance) is a common activity among adolescents!

The 2002 Ig Nobel in Mathematics went to Dr. K.P. Sreekumar and Dr. G. Nirmalan of the Kerala Agricultural University at Mannuthy, Trichur ,for their 1990 paper: "Estimation of the total surface area in India elephants (elephas maximus Indicus) " in Vet. Res. Comm. 14: 5-17, 1990. Working on 24 elephants, they devised a mathematical equation: [S = –8.245 + 6.807 H + 7.703 FFC] where S is the surface area, H the height at the shoulders and FFC the fore-footpad circumference. The mean surface area of an Indian elephant, using this equation was found to be 17.18 square meters. Now, why would want to estimate it? Because it indicates the total daily heat production (due to body metabolism), and thus aids in determining the necessary daily diet. One suspects that the jury which awarded the prize found the whole project exotic, the approach and the equation interesting, yet one that makes you think.

Very touching is the 2003 Ig Nobel for Peace which went to another Indian, Mr. Lal Bihari of Uttar Pradesh, for a triple achievement. Let me quote from the Ig Nobel site: "First, for leading an active life even though he has been declared legally dead; second, for waging a lively posthumous campaign against bureaucratic inertia and greedy relatives; and third, for creating the Association of Dead People. Lal Bihari overcame the handicap of being dead, and managed to obtain a passport from the Indian government so that he could travel to Harvard to accept his Prize. However, the U.S. government refused to allow him into the country. His friend Madhu Kapoor therefore came to the Ig Nobel Ceremony and accepted the Prize on behalf of Lal Bihari.

Several weeks later, the Prize was presented to Lal Bihari himself in a special ceremony in India". How noble of the Ig Nobel organisers!

Forget curtains, switch to smart windows

Scientists at Bengaluru have developed a smart window that automatically turns from transparent to opaque when heated and also gets back to its original transparent state when the heat is removed. These windows can potentially be used in homes, offices, and even cars and aeroplanes.

Researchers at the Centre for Nano and Soft Matter Sciences (CeNS) have come up with three different types of windows (thermochromic, hydrocarbon, hydrogel) with different behaviours. Windows made of hydrogel change from transparent to opaque when heated and back to transparent when heat is removed. Thermochromic and hydrocarbon windows are opaque at room temperature and become translucent and transparent respectively when heated.

Solar and electronic controls

Basic component of these optoelectronic devices (elec-

tronic devices that operate on both light and electrical currents) is the transparent heater. Thermochromic windows have an ordinary glass-based transparent heater coated with commercially available temperature-sensitive pigments. This allows it to turn from opaque to translucent when heated "This window can be used in cold winter regions, when you want the sun to warm up your room through passive smart window. By supplying very small (0.2 watts/cm2) current the transparency of the window can be changed according to your needs," explains Dr. Giridhar U. Kulkarni, Director at CeNS and corresponding author of the paper published in the Journal of Materials Chemistry C.

The second and third type windows were fabricated by filling in either hydrocarbon (commonly available fatty acid) or a hydrogel (hydroxypropyl methyl cellulose) between a glass mounted with transparent heater and a plain glass. "The hydrogel window is ideal for our Indian offices and homes. When the temperature reaches around 40 degree C, the glass turns opaque providing an efficient heat management system for offices with large windows. The windows can be also be controlled by providing just 0.2 watts/cm2 and it takes just two minutes to turn completely opaque," says S. Kiruthika, co-author of the work from Jawaharlal Nehru Centre for Advanced Scientific Research (JNCASR), Bengaluru.

The hydrogel windows can restrict infrared radiation thus reducing the indoor temperature. The researchers found that the temperature in an experimental control area with hydrogel window was nearly 10 degree C lesser than plain glass windows.

"All three types of windows are very cheap costing less than Rs.100 per sq foot. These can be installed to create less energy-consuming buildings," says Ashutosh K Singh, Research Associate, CeNS and first author of the paper.

'I would encourage The Hindu readers to help in shaping the Gallery'

Science Gallery International announced recently that historian of science and technology JahnaviPhalkey will be the founding director of Science Gallery, Bengaluru (SGB), which will be the first of its kind in India and only the third such gallery in the world. An author and a filmmaker, Dr. Phalkey has many academic distinctions to her credit, including an invitation to Fellowship at theWissenschaftskollegzu Berlin (Institute for Advanced Study, Berlin). Recently she was elected President of the Science and Empires Commission of the International Union for the History of Science and Technology. In an email, she talks about her plans for the Science Gallery, Bengaluru.

1. As founding director of the first Science Gallery in India what will be your immediate focus?

At this stage, my attention is focused on the building. We are working with Bengaluru-based architects on a structure that fits SGB which is premised on conversation and collaboration. Once construction is on the way, I would like to focus on building the relationships that will shape this institution. The first few years will be crucial for SGB to communicate its purpose as it finds its voice and the right tone for its mission. Equally, to an extent, these are the years that will publicly establish the ambition of and expectations from the institute. In that sense, as founding director, I will play a significant role in shaping the initial pathway. While the freedom to do so is apparent when compared with a similar position in an existing institution, it comes with a huge responsibility to place Science Gallery within the institutional and intellectual landscape of the country.

2. Is there a focal age group that you plan to engage with and what will be special about the gallery that will attract them?

Science Gallery programming is primarily focused on the 15-25 age group premised on the grounds that given the right nudge, appropriate tools and access to learning, they are able to creatively engage with science and engineering to handle important global challenges. This observation is all the more pertinent in India given the demographic dividend! That said, Science Gallery Bengaluru exhibitions and events should be of interest to older audiences as well.

3. Science Gallery also aims to get a handle on major problems facing us. What will be the initial focus and how will this be done?

Bengaluru is already witnessing an increased awareness [within] science institutions of the need to participate in collectively addressing some of our pressing concerns. The Gallery is the platform to harness this energy in bringing together different perspectives on the path to collaborative solutions. Engineers have long taken the problem-solving approach to generating new knowledge – other disciplines have actively resisted the increasing extension of the approach to other areas arguing, and rightly so, that knowledge production cannot be replaced by problem solving alone – it needs social engagement. In this context, SGB with its strong commitment to learn-

ing would like to focus on reflection and critical thinking alongside tinkering and a hands-on-approach to long-term learning. As for our topics, they could be anything from rare diseases to space travel, insects to addiction, blood to hustle.

4. How did the Science Gallery Bengaluru come into being?

Science Gallery originated in Trinity College Dublin a little less than 10 years ago, and Science Gallery International was grounded with a one-million-Euro gift from Google in 2012 to take the idea across the globe. Science Gallery Bengaluru is the third to be established in this extended network (London was the second) with Melbourne and Venice following close behind.

5. What is your message to the readers?

I would encourage The Hindu readers, irrespective of their professional choices, to bring their interests and concerns to Science Gallery Bengaluru and help shape an institution that is relevant to our immediate concerns which include the global aspirations of our scientific and artist communities. It might be interesting for many not already familiar with the landscape to explore projects like Ars Electronica (Austria), Arts Catalyst (UK) and The MIT Center for Art, Science & Technology, among others. In India, we have Khoj Workshop (New Delhi) with support from the DBT-Wellcome Trust and the ArtSciBLR at Srishti as well.

Novel anode for next-generation batteries in electric vehicles

One of the factors that determine the success of electric vehicles is the availability of batteries that can be charged quickly and retain enough charge to make long distance travel possible per charge. Researchers at the Indian Institute of Science Education and Research (IISER) Pune have synthesised a new type of anode material to make such a battery possible.

Unlike graphite anode-containing lithium ion batteries that have capacity of just 372mAh/gram, the anode synthesised by IISER researchers has double the capacity of about 720mAh/gram. The capacity remained the same even after 1,000 charge-discharge cycles.

The high capacity was seen when the rate of charging/discharging was 100mA/gram. But when the battery was charged quickly (1A/gram), the capacity reduced by about 20% (about 580mAh/gram).

“So even when the battery is charged quickly, it can still store about 80% charge,” says Prof. RamanathanVaidhyanathan from the Department of Chemistry at IISER Pune.

“And even when the battery was charged rapidly (2A/gram), the capacity was still around 500mAh/gram, which is much higher than the graphite-containing battery.” He is one of the corresponding authors of a paper published in the journal Advanced Energy Materials.

“The performance of the anode material is good in terms of capacity and stability,” says Dr. SatishchandraOgale from the Department of Physics at IISER Pune and the other corresponding author. “Graphite is cheaper and lithium ions can easily be inserted into graphite. But unlike the novel anode material, graphite can’t be tuned.”

Testing the anode

The researchers tested the capacity by replacing the graphite anode with the novel material (covalent organic framework) and used lithium metal as the cathode and not lithium cobaltate (LiCoO2), which is normally used as the cathode.

“We had tested the anode using a half-cell configuration. To realise the full potential of the novel material it has to be tested in a full-cell configuration,” he says.

When tested in a full-cell configuration, the charge will be lower than what has been observed by the researchers. This is because the kinetics of lithium diffusion will be different depending on the cathode material used and the configuration of the battery.

“The capacity of a graphite anode in a full-cell configuration will be only about 150mAh/gram if the battery is charged quickly (rate of charge is 1A/gram). So with our anode material, even if the capacity drops by 50% in a full-cell configuration, the capacity will be about 360mAh/gram, which is much higher than graphite. This can be confirmed only when we carry out an experiment using full-cell configuration,” says Prof. Vaidhyanathan.

The anode made of a few-layer thick (6-8 layers) nanosheets has pores lined by functional groups capable of interacting with lithium ions. The pores provide an easy path for diffusion of lithium ions and helps access the functional groups, which are sites of lithium ion interaction.

“Optimal interactions allow lithium ions to go in and come out of the nanosheets with ease allowing the anode to discharge easily,” says SattwickHaldar from the Department of Chemistry, IISER Pune and first author of the paper.

Charging and capacity

The ease with which lithium ions go in and come out of the nanosheet anode changes when the time taken to charge the battery changes. When it is charged quickly,

the efficiency of lithium ions diffusion drops and capacity of the battery reduces. “In our case, whether the battery charging time is short or long (50mA/gram or 2A/gram), the capacity does not change much,” says Prof. Vaidhyanathan.

The anode was tested in a coin cell and not a bigger battery that would typically be used in electric automobiles. The researchers are trying to scale-up the battery so that it can potentially be used for applications that need higher battery output.

An audacious attack on the sphere-stacking problem

On December 21 and 22 at a function held in Kumbakonam, in Tamil Nadu, Maryna Viazovska, Ukrainian mathematician who is currently based at Swiss Federal Institute of Technology, Lausanne, was awarded the SASTRA Ramanujan Award. She was given the award for having solved the problem of what is the densest possible way of stacking of spheres in eight and 24 dimensions. The problem is centuries old and Prof. Viazovska’s proof involved ingenious use of the so-called modular forms – one of Srinivasa Ramanujan’s favourite topics. The prize is given annually to mathematicians under 32 who have made a remarkable contribution to mathematics in areas related to Ramanujan’s work and ideas. Other mathematicians who have been given this award have gone on to win awards like the Fields Medal and the Cole prize.

The chairperson of the SASTRA Ramanujan Award Committee and professor of mathematics at University of Florida, U.S., KrishnaswamyAlladi says, “There were four contenders for the award, but Maryna Viazovska was chosen because the problem itself is such a long-standing one and she has come up with such an ingenious solution.”

The densest packing of spheres in space was known only in dimensions 0, 1, 2 and 3 until Viazovska proved it for dimensions eight and 24.

If we had a set of oranges and wanted to stack them on a table most efficiently, we would automatically stack them first on the table in an alternating arrangement so that every orange has six nearest neighbours. This is the problem in two-dimensions, the plane of the table. If we wish to make a three-dimensional stacking, we would place the second layer on top of the tiny spaces we see between three neighbouring oranges. Building layer by layer in this manner, we would be able to solve the packing problem in three dimensions.

However, while it is easy to intuitively judge this, we cannot prove that this is the best way and no other way of stacking oranges can match this. The seventeenth century mathematician Johannes Kepler, famous for having given the description of planetary orbits, was intrigued by this problem in three dimensions. But the proof of the packing problem in three dimensions had to wait until 1998 when Thomas Hales, now at Pittsburgh, proved it mathematically.

The packing problem’s proof for dimensions higher than three is further complicated because once the dimension increases the interstices between the spheres become so large that you can put additional spheres in it.

Leech lattice

Maryna Viazovska has shown that if you place the spheres such that their centres lie on the points of what is called an E8 lattice, then that is the densest stacking in eight dimensions. In 2001, Henry Cohn of Microsoft Research, Cambridge, and Noam Elkies, Harvard University, showed that the E8 lattice came close to being the densest packing in eight dimensions. They “conjectured,” or guessed, the existence of some magic functions which can resolve the problem. In fact, they also talked about dimension 24 in the same vein.

In what has been described as an audacious attempt, Prof. Viazovska used the so-called modular forms very creatively to find these functions, first in 8 dimensions and then, in collaboration with others, in 24 dimensions. If there is the E8 lattice in 8 dimensions, there is the so-called Leech lattice in 24 dimensions, and these were shown by her to have the densest packings in eight and 24 dimensions, respectively.

Prof. Viazovska’s papers have been published in the Annals of Mathematics.

Injunction against Hyderabad’s OMICS to stop ‘deceptive practices’

The Federal Trade Commission (FTC) has won the first court battle against the Hyderabad-based OMICS Group, which publishes over 700 journals. A federal district court in the District of Nevada granted a preliminary injunction temporarily halting the deceptive business practices of OMICS. The FTC had charged OMICS with making false claims about their journals and academic conferences.

The “preliminary injunction prohibits the defendants from making misrepresentations regarding their academic journals and conferences, including that specific persons are editors of their journals or have agreed to participate in their conferences. It also prohibits the defendants from falsely representing that their journals engage in peer review, that their journals are included in any academic journal indexing service, or any measurement of the

extent to which their journals are cited. It also requires that the defendants clearly and conspicuously disclose all costs associated with submitting or publishing articles in their journals".

The lawsuit

The lawsuit against OMICS Group and Chief Executive Officer SrinubabuGedela was filed in August 2016 accusing the defendants of deceptive business practices.

The FTC had alleged that the defendants deceptively claimed that their journals provide authors with rigorous peer review and have editorial boards made up of prominent academics. In fact, however, many articles are published with little or no peer reviewing and many individuals represented to be editors have not agreed to be affiliated with the journals.

The FTC also alleged that the defendants seldom tell authors about publishing fees, which is significantly high, and once submitted, OMICS does not allow authors to withdraw their manuscripts. This makes it nearly impossible to submit to other respected journals for publication. The FTC also alleged that there were misleading claims made by OMICS about impact factor and indexing in PubMed.

"Papers published in OMICS journals are peer reviewed as per international standards," claims Mr. Gedela in an email to The Hindu. But contrary to his claims, a couple of sting operations have revealed how poor or non-existent the peer-reviewing process is for papers published in OMICS journals.

"The Court ordered [that] if OMICS is following any deceptive practice identified by FTC then OMICS should stop that deceptive practice. But as communicated [to you over phone], FTC has failed to prove any allegations or deceptive practice of OMICS even during two years' of their investigation. We are not misrepresenting anything," he claims. "In my opinion, the FTC team is trying its level best to support its stand as it has become a prestige issue."

In response to a question by The Hindu that OMICS has been ordered to remove all misleading claims from its websites Mr. Gedela says: "Yes, Court [has given a] preliminary injection order to remove any misrepresentation or misleading claims. OMICS is following that and not [putting out] any misleading information or claims."

Peer regard

Mr. Gedela claims that PubMed is restricted to the U.S. "There are so many indexing databases for different countries and for different subjects," he says. Unfortunately, the indexing databases that Mr. Gedela is referring to such as the Index Copernicus is treated with scorn by the scientific community.

"The lawsuit and judge's order were not an attempt to regulate the journals or conferences themselves. We want to make clear that this has nothing to do with the content. Nothing in this order goes to what they can or can't publish in terms of content. This is about how they are soliciting would-be academics to publish in their journals," Gregory Ashe, a senior attorney for the FTC's division of financial practices told Retraction Watch.

"The intention behind the preliminary injunction is to stop misrepresentation and to get the required information from us. It is not to halt any of our operations in the United States," Mr. Kishore Vattikoti, Senior legal counsel for OMICS International said in an email to The Hindu.

One butterfly at a time

It's not often that I will finish a book, that it leaves me amazed at the richness and expanse of its ideas … and that I have to confess I did not understand fair chunks of it. Butterfly in the Quantum World is such a book. Please understand: I have no problem making that confession. Because even if there were parts I had to skim over—mere mathematical dabbler that I am—I was also filled with an increasing wonder at the niches explored, the connections made. In that sense, IndubalaSatija, its author, made me feel that in merely reading her book, I had become a partner in her own journey of wonder.

The story begins with a certain mathematical construct, if you will—though that word implies a mundanity that really does not apply. In playing with number sequences as a mathematically inclined teenager, the cognitive scientist Doug Hofstadter (author of Gödel, Escher, and Bach) stumbled on a particular pattern that concealed within itself, of all things, a copy of itself. (See my earlier column here, "Butterfly on the wall" . Now in a very real way, mathematics lives on patterns, and its practitioners—teenagers included—thrive on them. Entire careers have flowered in the search for meaning in such patterns, maybe even more so when they can be defined and described recursively, in terms of themselves, as Hofstadter's pattern was.

Years later, as a PhD student in solid-state physics, Hofstadter was studying the behaviour of electrons in crystals subjected to magnetic fields. When he stumbled on a deep connection to his teenaged discovery with numbers, you can imagine how astonished and delighted he was. Who would have thought it?

He captured the relationship between the energy levels of these electrons and the magnetic field in a graph he called "Gplot". Thing is, as far as I can tell; only Hofstad-

ter has ever used that name. Pretty much every other scientist who has explored its charms—and there are many such, both charms and scientists—knows it as the "Hofstadter Butterfly." If you take a look at it, you'll know why. Especially when coloured as in InduSatija's book, it looks a whole lot like one of those beautiful insects that flutter by, catching the sun and filling us with, yes, wonder.

Satija is a physicist at George Mason University in Virginia. She ran into Hofstadter's Butterfly early in her career, and found that it fluttered by over and over through the years. The connections thrilled her, to the extent that she began compiling them into a book. In 2014, she sent Hofstadter a draft. It thrilled him too, to the extent that he wrote a prologue, a "guest chapter" and worked closely with Satija to chisel the draft into the finished product. At one point, he writes of his butterfly and of all that's in this book:

"Little did I suspect that from these humble beginnings would flow so many other results in the coming decades. Although I didn't participate in those discoveries, I have watched them from the sidelines with great interest, and it gives me a feeling of pride and privilege to have had the good fortune of playing a role in the launching of this fertile, multifaceted area of research in physics."

"Multifaceted" is right on the money. As Satija tells us, the butterfly makes an appearance in quantum physics. In a certain arrangement of circles named for the ancient Greek mathematician Apollonius ("Apollonian gasket"). In the "anholonomous" behaviour of Foucault's pendulum, which demonstrates Earth's rotation by not returning to its initial state? In topology, the study of surfaces.In the behaviour of light. There's plenty more, including hints at research and results still unknown, still to be discovered. I mean, there's almost no limit to the connections—which is itself a reminder of the recursion at the heart of Hofstadter's original discovery with his number sequences. My father loved the Marx Brothers' films because he said the brothers managed to wring every possible joke out of a situation, a conversation, sometimes even a word. I thought of that seemingly effortless wringing all through this book. Because there's endless meaning and analogy to be drawn from Hofstadter's Butterfly, and actually you don't even have to wring it out.

The book is littered with examples of Satija's wide-eyed wonder at the endless delights of the Hofstadter butterfly. It's worth dipping into purely for them.

But yes, it's true: I know too little physics and mathematics to understand various parts of this book. Even so, I enjoyed it a great deal, and I realize that probably sounds like a contradiction. So I'm going to try to explain why, and why I think you will similarly enjoy the book.

Early in the book, Satija offers us this quote: "A mathematician … who is not at the same time a bit of a poet will never be a full mathematician." That spirit runs through the book like a sparkling chain of jewels. I always think that if more of us can come to see mathematics that way, to feel that love for it—instead of the fear that seems more common—this world we inhabit would be a better place by far.

Consider just two examples.

In 1885, a Swiss schoolteacher called Johann JakobBalmer found a simple formula that described mathematical patterns that he loved observing in nature. It might have stayed as obscure as Balmer's name probably is to most of us.

But a few decades later, the great Danish physicist Niels Bohr theorized an explanation for certain dark lines in the spectrum of hydrogen, involving the energy levels of its electrons. Bohr won the Nobel Prize in Physics for this discovery in 1922.

But amazingly, Balmer's equation actually gives us those lines, which is why they are now called Balmer lines. As Satija explains, "[A]ll of a sudden, the world understood why the Balmer formula was the way it was, and with that, the profound mysteries of the atom were starting to be unlocked."

Look around you for patterns and who knows—one day somebody may connect them to the "profound mysteries of the atom" and win a Nobel Prize. Wow.

Satija devotes several chapters to exploring the butterfly's connection to the "quantum Hall effect", a remarkable property, discovered in 1980, of how certain materials conduct electricity while subjected to a magnetic field. The effect, thus, turns out to be related to the Apollonian gasket I mentioned above. "How unexpected", she writes, "that a beautiful and abstract piece of mathematics from well over 2000 years ago" is connected so intimately to a 1980 discovery. In fact, when we observe the quantum Hall effect, "we are seeing … a reincarnation of an Apollonian gasket from way back in 300 BC!"

The book is littered with examples, like these, of Satija's wide-eyed wonder at the endless delights of the Hofstadter butterfly. It's worth dipping into purely for them.

And then there are the "contributions" of Hofstadter himself. His own delight is no less evident, as he pursues ever-more intricate patterns and their implications. Like the time when he spends several pages explaining and deriving something called Harper's equation. On the way,

he shows us an interim equation to make your eyes glaze over (mine did, I admit), but comments: “This feels magical, like pulling a rabbit out of a hat, does it not?” A few lines later, he says the equation would likely “leave most cosine-savvy high-school students choking in the dust. … But I think that it’s important to point out and to savour such magically fluid thinking.”

My eyes glazed over, certainly. But I also savoured the thinking. For the number of times “magic”, “poetry” and their variants appear in this book tells a story by itself.

So it’s only appropriate that the last chapter has several poems: four winners in a Butterfly contest Satija organized, and one by Satija and Hofstadter (“It’s one, yet it’s infinity/Eternity, sublimity/Divinity and mystery/It’s raga, yet it’s poetry.”)

And in a Coda, Satija finds a connection to her Indian roots as well: in lines from Bhaskara’s Lilavati, “a little gem of poetic verse where love, beauty and mathematics are braided together.” It’s a puzzle about a swarm of bees that Bhaskara poses in those lines, and he ends it thus: “Say, lovely woman, the number of bees.”

Honestly, I didn’t need to understand everything in this book. It’s in its spirit, its scientific and mathematical curiosity, its willingness to be surprised at every turn, that it speaks loudest to me. It’s the reason mathematics is such an elegant, rewarding pursuit. It explains what I feel about Satija and Hofstadter: jointly, one butterfly at a time, making this a better world.

Bakhshali, Jambudvipa and India’s role in science

London’s Science Museum unveiled a new exhibition that traces India’s contribution to science and technology over the past 5,000 years. Bringing together pieces from scientific institutes and museums across India as well as those held by British institutions, the Indian High Commission and the museum hope to be able to bring the exhibition to India too.

The highlight is a folio from the Bakhshali manuscript, loaned to the exhibition by the Bodleian Library in Oxford, which contains the oldest recorded origins of the symbol “zero”.

Dated to 3rd century

In September, the Bodleian revealed that new carbon dating research into the manuscript revealed it to be hundreds of years older than originally thought and that it could be dated back to the third or fourth century.

Another remarkable piece is an 1817 version of Jambudvipa, or Jain map of the world, and a spectrometer from 1928 designed by Nobel Prize winner C.V. Raman. The exhibition also covers significant recent contributions — from the Jaipur foot that has been used across 27 countries to the Intel Pentium processor and the Embrace Nest Neonatal pouch. The exhibition also highlights writings by some of the most influential figures, including letters from S.N. Bose to Albert Einstein, held by the Hebrew University of Jerusalem, and selected papers of Srinivasa Ramanujan, held by Trinity College Cambridge.

It also includes an index chart of the great trigonometrical survey of India from 1860, which it says “no map in the world at that time could rival” for scale, detail and accuracy.

“It encapsulates what India has gone through in terms of science and technology in the past five thousand years,” said India’s Deputy High Commissioner to the U.K. Dinesh Patnaik, who hopes to work with the museum to take the exhibition to India.

“We wanted to tell that story of India’s role in science and technology which is an incredibly difficult and complex thing to do— - we wanted to capture just how far reaching it has been in shaping science and technology,” said the exhibition’s head of content Matt Kimberly, pointing in particular to the spectrometer and the influence it had in shaping industries from forensics to art conservation.

Growth of photography

A separate exhibition charts the growth of photography in India. One section of it focusses on 1857 and includes the bizarre growth of what it refers to as “mutiny tourism”, which led to sites of conflict and suffering getting turned into “postcards, stereocards and prints for a burgeoning British tourist industry”.

It also includes works by artists like Ahmad Ali Khan, the court photographer to the last king of AVadh, and Felice Beato. The exhibition also focuses on 1947, and includes works by photojournalists Henri Cartier Bresson and Margaret Bourke-White.

Organic near-IR filter developed

An organic filter that allows only near-infrared (NIR) light to pass through has been developed by scientists at the CSIR-National Institute for Interdisciplinary Science and Technology (CSIR-NIIST) based in Thiruvananthapuram. The filter can be used for night vision glasses, night photography, and will have applications in security and forensics such as identifying blood stains on a dark fabric.

Currently available inorganic filters are expensive and brittle whereas organic filters are easy to process and

flexible too. The filter was prepared by mixing a black dye (diketopyrrolopyrrole or DPP) having an amide group that helps the molecules to be in close contact with each other and interact leading to changes in their optical properties. "The amide group helps in binding and self-assembly of the molecule leading to the formation of a soft organogel," says Dr. AyyappanpillaiAjayaghosh, Director of NIIST, who led the team of researchers.

Organogel is key

The organogel-based filter has the ability to absorb both ultraviolet and visible light while allowing the near-infrared light alone to pass through. The nanofibres formed through the self-assembly of the DPP molecules are responsible for the broad light absorption of the material, making it appear dark.

The researchers developed the filter by mixing the organogel with a transparent polymer (polydimethylsiloxane). The addition of the dye turns the transparent polymer into a semi-transparent one and the filter appears black as it absorbs most of the ultraviolet-visible light.

"Only very little of the organogel has to be added to the polymer to make the filter. The material is present throughout the polymer matrix even though very little is added," says Samrat Ghosh from the Chemical Sciences and Technology Division at NIIST and the first author of the paper published in the journalAdvanced Materials .

The filter was found to absorb light from 300-850 nm (both ultraviolet, visible and a part of NIR light) and transmit NIR light from 850-1500 nm. The researchers tested it for night photography and found the filter responsive only to NIR light.

Dried blood strains on a black cloth that remained invisible to naked eyes became clearly visible and detectable when viewed through a camera with the NIR filter. Tampering of a cheque which was not discernible to naked eyes could be easily identified when viewed through a camera with the filter.

Another potential application of the new material is in the design of hidden security codes on documents which can be viewed only through a NIR-readable camera.

SC bans use of pet coke in NCR

The Supreme Court directed the prohibition of industrial use of pet coke and furnace oil in NCR regions from November 1, 2017. The order follows the recommendation of the Supreme Court-appointed Environment Pollution Control Authority (EPCA) to ban the sale, distribution and use of furnace oil and pet coke in the NCR. Their use is already prohibited in Delhi.

A Bench led by Justice Madan B. Lokur also imposed a fine of Rs. 2 lakh on the Ministry of Environment for not fixing any emission standards for industries using pet coke and furnace oil in the NCR region.

Casting its net wider against sources of air pollution and government apathy after recently cracking down on the sale of firecrackers during Deepavali, the Supreme Court said fixing emission norms for industries using these toxic materials was vital for public health.

'Lethargy, laziness'

The delay on the government's side, the court said, was symptomatic of "lethargy and laziness."

Snubbing the Ministry for submitting draft norms only on October 23, the court said failure from the Ministry's side to pay the Rs. 2 lakh fine would invite serious penalties.

In a separate hearing, the same Bench, led by Justice Lokur, ordered the demolition of a high-tech, multi-parking lot built a kilometre from the Taj Mahal. Uttar Pradesh Chief Minister Yogi Adityanath is expected to visit the monument on October 26 to review tourism schemes. The court gave the authorities four weeks to demolish the parking lot.

Later in the day, counsel for the U.P. government sought a recall of the order, but the court asked her to move an appropriate restoration application. The order came on a PIL petition filed by advocate M.C. Mehta for protection of the monument from pollution and deforestation.

IIT Madras develops extremely water-repellent coating

Nanocellulose-based liquid dispersion that renders the coated surface extremely water repellent — superhydrophobic with water contact angle more than 160 degrees — has been developed by a team of researchers led by Prof. T. Pradeep from the Department of Chemistry at the Indian Institute of Technology (IIT) Madras.

The material can be coated on a variety of surfaces including glass and paper. It has several distinct properties such as high mechanical durability and chemical stability. Like other superhydrophobic materials, the dispersion-coated surface exhibits microbial resistance thus preventing biofouling.

The researchers used cellulose nanofibres (5-20 nm wide and more than 500 nm in length) and functionalised them with flurosilane in water over six-seven hours at room temperature. The linkage of fluorosilane with cellulose happens through the hydroxyl groups present on cellulose.

The functionalisation makes the long fibres of cellulose, resembling bamboo poles of molecular dimensions, to be covered with fluoroalkyl groups. This reduces the surface

energy of cellulose fibres. Low surface energy together with enhanced surface roughness at nanoscale renders the coated surface highly water-repellent. Tiny water droplets dropped from a height bounced off the coated surface attesting the extreme water-repellence. Other tests too confirmed superhydrophobicity.

"The functionalisation process avoids the use of organic solvents. This makes it safe and eco-friendly. This science helps expand the use of sustainable materials. And similar to water, the dispersion is not sticky thus making it easy to coat or spray paint on any surface," says Prof. Pradeep.

Superior durability

The coating exhibited superior mechanical durability even when subjected to a variety of abrasion tests — scratches using a knife, peel-off test and sand paper abrasion. "There was negligible reduction in water repellence even when subjected to wear and tear. The covalent linkages between the cellulose fibres provide superior mechanical stability to the coating," Prof. Pradeep says. The coating also strongly adheres to the surface.

Even when exposed to organic solvents such as hexane and ethanol, the coating exhibited chemical stability and retained its extreme water-repelling property. "The coating absorbs organic solvents. Once the coating dries, which happens very quickly, the water-repelling property returns," says AvijitBaidya from the Department of Chemistry, IIT Madras and the first author of the paper published in the journal ACS Nano.

"The coating remained stable even when subjected to extreme temperatures of 200 degree and –80 degree and exposed to direct sunlight," says Baidya. "The longevity was also tested for two years under laboratory conditions."

Despite the extreme water repelling property, coated paper absorbs organic components. "Since ink has organic components, the coating allows the ink to diffuse. Unlike normal paper where the ink washes off when exposed to water, the ink on the coated paper remained intact even when in contact with water," says Baidya.

Though the coating strongly adheres to glass and exhibits all the desirable properties, light transmission gets compromised as the coating turns the glass white. "This material is truly not for glass. Better applications will be in paints and for coating the paper used for printing currency," says Baidya.

The team is already working to address the issue of light transmission by using a starting material other than cellulose. "We have nearly developed a superhydrophobic material that remains transparent once coated," says Prof. Pradeep, who is the corresponding author.

"We are willing to commercialise the product either through a start-up or by licensing it. We have already filed for a patent," He says.

IIT Bombay makes analog device that mimics neurons

Manufacturing a brain-like chip made of artificially fabricated neurons is one aim of scientists working in the field of artificial intelligence. There have been some attempts to make this happen. Recently, a team comprising researchers from IIT Bombay and IIT Gandhinagar has succeeded in fabricating an artificial neuron. The work is published in the journal Scientific Reports.

This silicon neuron is an analog device that mimics the biological neuron in that it fires a spiky signal when it detects simultaneously occurring inputs from outside. The team tested the neuron by checking whether a network of such neurons can perform select classification tasks. One task it succeeded in was to distinguish between different species of the iris flower – Iris sentosa, Iris virginicaand Iris versicolor . The other, more significant, was that it could classify benign and malignant cancers.

LIF neuron

The schematic of the neuron is as follows: Two so-called pre-neuron drivers are connected to the external circuit, and these feed into two electronic "synapses." These synapses convert the voltage spikes into smooth current variations and feed it into the Leaky Integrate and Fire neuron (LIF neuron) as it is named. In the neuron, the inputs from two synapses are added up by means of a capacitor circuit. As is the nature of the capacitor, when the added current reaches a threshold, the capacitor discharges, giving a means of resetting the current value.

This signal is fed to the "post-neuron driver" which fires when the total current is above a certain value. That is, it fires not at points corresponding to inputs from single synapses, but at points corresponding to signals from both synapses only. This is like how the biological neuron behaves – it ignores isolated inputs and fires when there are simultaneous inputs from many synapses. Like the biological neuron, after firing, it is reset to zero.

"We have only demonstrated the capability of several unit devices [SOI MOSFET] as an efficient analogue to the biological neuron. The challenge remains in the demonstration of complete neural network in hardware where many such neurons will be interconnected and perform some meaningful tasks," says Sangya Dutta a graduate student at the Electrical Engineering Department of IIT Bombay and first author of the paper.

Today, popular search engines are able to recognise voice and images using software implemented on traditional digital server farms that guzzle energy. Comparing this with the device they have developed, UdayanGanguly of the Electrical Engineering Department of IIT Bombay, in whose lab this research was done, says: “The energy efficiency in biology partly lies in the neurons’ ability to code information as tiny ‘voltage spike’ rather than digital ‘1’ or ‘0’ expressed as high and low voltages. Our silicon-based neuron enables AI tasks with improved energy efficiency compared with digital implementation.”