

News for Jan-Mar 2017

# **SCIENCE AND TECH.**

**THE CRUX OF THE HINDU**

**Vol. 09**

## **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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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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## SPACE

### NASA's Curiosity rover finds purple rocks on Red Planet

Recent photographs taken by NASA's Curiosity rover have revealed purple rocks on the surface of Mars. NASA officials have said this may suggest a greater degree of diversity in the geological composition of the region..

Discovering new drugs that bind to G Protein-Coupled Receptors (GPCRs), which are central to almost every physiological process in our body such as vision, taste, immune response and cardiovascular regulation, has become easier, thanks to research by a team led by Dr. Arun K. Shukla from the Department of Biological Sciences and Bioengineering, Indian Institute of Technology (IIT) Kanpur.

Nearly 50 per cent of prescription drugs currently available in the market for the treatment of blood pressure, heart failure, diabetes, obesity, cancer and many other human diseases target GPCR receptors. All these drugs bind to their respective receptors and either activate or stop their signalling. The work by Dr. Shukla's team has shown that the regulation of these receptors by these drugs can be simpler than generally thought — it can be mediated by engaging only the end of the receptor, which is called the tail of the receptor.

The results were published in the journal Nature Communications.

Receptors found on the cell surface receive signals and transmit them to inside the cells. A part of the receptor is embedded in the cell membrane and the other part protrudes outside the membrane and inside of the cell. The part of the receptor that protrudes outside the membrane changes its shape whenever a stimulus in the body binds to it. In response to this change in the outside part of the receptor, a corresponding change happens in the shape of the receptor that is positioned inside the cell. This change in the shape of the receptor positioned inside the cell allows it bind to other proteins called effectors. These effectors cause specific effects in the cell, referred to as cell signaling, which leads to physiological changes in our body.

For example, a hormone in the blood called angiotensin binds to its receptor and activates the effector protein inside the cell causing an increase in blood pressure.

#### **The mechanism**

In people with normal blood pressure, a specific type of proteins called arrestins, which are effectors proteins of

GPCRs, bind to the receptor and pull it inside the cell (a process called receptor endocytosis). This prevents the angiotensin from binding to the receptor, thereby help in controlling the blood pressure.

In the case of people with high blood pressure, the prescribed drug binds to the receptor. So even if angiotensin is present on the surface of the cell, it cannot bind to the receptor and start the signaling process that increases blood pressure.

#### **New approach**

"We were interested in understanding how different receptors interact with effectors and how the receptors recognise the stimuli," says Dr. Shukla. "We looked at the interaction of a receptor, which is a target for heart failure drugs, with its specific effectors, namely arrestins. When arrestins bind to the receptor, they arrest or disrupt the receptor signaling."

"The text book understanding is that arrestins have to simultaneously bind at two sites — the tail of the receptor and the core of the receptor — for the drug to become effective in pulling the receptor inside the cell [to prevent the stimuli from binding to the receptor and start signaling]," says Dr. Shukla.

"Through specific engineering of the receptor we basically disrupted one of the two binding sites, namely the core of receptor. We found that even without the second site, the arrestin was able to pull the receptor inside the cell by binding just to the tail of the receptor [which is the other binding site]," he says.

There is a key region in the core which the team genetically deleted thereby making the core of the receptor ineffective.

"Whenever researchers are designing a drug to stop GPCR signaling, they look for a drug that simultaneously triggers the binding of arrestins to both the sites in the receptor. Our work changes the way people will look at drug discovery for GPCR signaling," he says. "The drug has to trigger binding of arrestin to just at the tail of the receptor to arrest the signaling. Researchers can now design simple drugs to accomplish this."

### 'Leap second' syncs Indian time with Earth's spin

A 'leap second' was added to the Indian clock at 5:29.59 hours to synchronise with the Earth's rotational clock. As the atomic clock at the National Physical Laboratory (NPL) here struck 23:59:59 last night, it was programmed to add an extra second to 2017 to compensate for a slow-down in the Earth's rotation.





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Adding a second barely has an impact on the daily life, but it does matter in the fields of satellite navigation, astronomy and communication. "The Earth and rotation around its own axis is not regular, as sometimes it speeds up and sometimes it slows down due to various factors, including earthquakes and moon's gravitational forces. As a result, astronomical time (UT1) gradually falls out of sync with atomic time (UTC), and, as and when the difference between UTC and UT1 approaches 0.9 seconds, a leap second is added to UTC through atomic clocks worldwide," D. K. Aswal, Director of NPL, said.

#### **Extreme precision**

Adding the leap second to the Indian clock is done by the NPL under the Council for Scientific and Industrial Research. The NPL, one of the oldest laboratories in the country, has five atomic clocks and nearly 300 such pieces exist across the globe.

Atomic clocks are so precise that the margin of error in its functioning is just of a second in 100 million years.

"The leap second adjustment is not so relevant for normal everyday life. However, this shift is critical for applications requiring time accuracies in the nanosecond, which are critical in the fields of astronomy, satellite navigation, communication networks," Mr. Aswal added. — PTI

The Centre will meet its fiscal deficit target of 3.5 per cent of the gross domestic product (GDP) for 2016-17 despite a slew of sops announced by Prime Minister Narendra Modi last week, Railway Minister Suresh Prabhu said.

"The voluntary income disclosure scheme has already given us some revenue and this (demonetisation) scheme will also bring in some revenue so we will be able to meet the (fiscal deficit) target. The Prime Minister's announcement will be definitely honoured in terms of ensuring fiscal adherence to all our commitments as well as fiscal prudence," Mr. Prabhu informed the media while elaborating on the government's anti-corruption measures days after the deadline to deposit old Rs. 500 and Rs. 1,000 currency notes in banks ended.

#### **Relief package**

Mr. Modi announced a package for farmers, senior citizens, small entrepreneurs, women and the rural poor along with a housing scheme for the poor and the middle-class in a bid to provide relief from the impact of demonetisation of high-value currency notes which he had announced on November 8. "The government has exercised the highest form of fiscal prudence. We have met each one of our fiscal deficit targets so far," the Minister said.

#### **Widening deficit**

The Centre's fiscal deficit remained high at Rs. 4.6 lakh crore, which was 85.8 per cent of the budget estimates for the entire financial year, till the end of November this fiscal year. Till October, the deficit was slightly lower at 79.3 per cent of the full fiscal deficit target. The Union Budget had estimated fiscal deficit at Rs. 5.33 lakh crore for 2016-17 which works out to 3.5 per cent of the GDP. The fiscal deficit widened in November mainly due to muted gross tax revenues.

The Minister also said that high bank deposits due to demonetisation would lead to more savings that would in turn lead to higher investments. "Much of the money coming in(to) the banking system will enable banks to lend more. When money comes into the banking system, the savings rate of the economy will increase and more money will be spent on infrastructure. China has seen high economic growth because of good savings rate," he said.

#### **A sneak peek into a 'star factory' at work in massive Milky Way nebula**

The European Space Agency released stunning images of baby stars taking shape inside the Milky Way's Orion nebula.

The massive Orion A molecular cloud is the "star factory" closest to Earth, and has given astronomers a front-row seat to observe how stellar objects come into being.

A nebula is a widely scattered cloud of interstellar gas and dust.

#### **1,350 light years away**

Also known as Messier 42, the Orion nebula is some 1,350 light years from Earth, and has a mass 2,000 times greater than the Sun.

Very young stars cannot be seen in the visible light spectrum.

But European Southern Observatory's VISTA telescope in Chile — the largest in the world dedicated to surveying the heavens — pierced the dust that shrouds them by zeroing in on infra-red wavelengths.

The new image survey "allows the earliest evolutionary phases of young stars within nearby molecular clouds to be systematically studied," the European Southern Observatory said in a statement.

The project has so far identified nearly 8,00,000 new stars, young "stellar objects" and distant galaxies.

The Orion nebula, visible with the naked eye in the night sky, was first scientifically described in the early 17th century.

In 1789, British astronomer William Herschel — using



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a home-made two-metre telescope — prophetically described nebula such as Orion as “the chaotic material of future Suns.” — AFP

### ‘Earth’s day lengthens by two milliseconds a century’

Astronomers who compiled nearly 3,000 years of celestial records have found that with every passing century, the day on Earth lengthens by two milliseconds as the planet’s rotation gradually winds down.

The split second gained since World War I may not seem much, but the time it takes for a sunbeam to travel 600km towards Earth can cost an Olympic gold medal, as the American Tim McKee found out when he lost to Sweden’s Gunnar Larsson in 1972.

For those holding out for a whole extra hour a day, be prepared for a long wait. Barring any change in the rate of slowing down, an Earth day will not last 25 hours for about two million centuries more.

Researchers at Durham University and the U.K.’s Nautical Almanac Office gathered historical accounts of eclipses and other celestial events from 720 BCE to 2015. The oldest records came from Babylonian clay tablets written in cuneiform, with more added from ancient Greek texts, such as Ptolemy’s 2nd century *Almagest*, and scripts from China, mediaeval Europe and the Arab dominions. The ancient records captured the times and places that people witnessed various stages of solar and lunar eclipses.

To find out how the Earth’s rotation has varied over the 2,735-year-long period, the researchers compared the historical records with a computer model that calculated where and when people would have seen past events if Earth’s spin had remained constant.

“Even though the observations are crude, we can see a consistent discrepancy between the calculations and where and when the eclipses were actually seen,” said Leslie Morrison, an astronomer on the team. “It means the Earth has been varying in its state of rotation.” Astronomers have long known that Earth’s spin is slowing down. The main braking effect comes from tides caused by the moon’s gravity.

Changes in the world’s sea levels and electromagnetic forces between Earth’s core and its rocky mantle had effects on Earth’s spin too, according to the scientists’ report in *Proceedings of the Royal Society*. The different forces seem to drive cycles in the Earth’s rotation spanning decades to centuries, with one cycle repeating every 1500 years. — Guardian News and Media Ltd.

### Resourcesat-2A joins the observation deck

Remote sensing satellite Resourcesat-2A was launched from Sriharikota at 10.24 a.m. . It was the only passenger flown aboard the PSLV-C36 rocket.

“It was a perfect launch,” declared A.S. Kiran Kumar, chairman of the Indian Space Research Organisation, after confirmation came 18 minutes later that the satellite had been deployed at 824 km from Earth.

“We have put one more operational [Earth observation] satellite in orbit,” he said in an address from the launch complex, the Satish Dhawan Space Centre in coastal Andhra Pradesh.

The 1,235-kg spacecraft now orbits in a pole-to-pole sun-synchronous path close to the intended position, inclined 98.7 degrees to the equator. The orbit will be adjusted slightly in the coming days by the ISRO Telemetry, Tracking and Command Network in Bengaluru.

#### What it means?

Resourcesat-2A is a follow-on to two predecessor spacecraft for the observation of Earth from space. For at least the next five years, it ensures continuous three-tier remote-sensing data. Resourcesat-1 was put in space in October 2003 and Resourcesat-2 in April 2011, each with a planned life of five years.

The first images are expected from December 15. Once its orbit is stabilised and it is paired with Resourcesat-2, the new spacecraft will start giving improved and more frequent data, said satellite director S.K. Nagesh.

The satellite’s three cameras of different resolutions will soon start giving regular micro and macro information about the land and waterbodies below, farmlands, their crop area and production estimation, forests, soil mapping, drought, mineral deposits, and rural and urban spreads, besides guiding in disaster management, ISRO said.

According to an ISRO official, the AWiFS (Advanced Wide Field Sensor) provides images of 56-metre resolution, which would be useful at the State level. The LISS-3 (Linear Imaging Self-scanning Sensor) of 23.5-metre resolution can take pictures at the district level, while LISS-4 (5.6 metres) can provide taluk-level information.

#### Success streak

In 2016, nine missions have taken off successfully from the Satish Dhawan Space Centre, including the more powerful GSLV, said launch centre director P. Kunhikrishnan. For the light-lifting PSLV, it was the 37th straight successful flight. It was configured in the extend-



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ed XL version that has six small strap-on motors. ISRO's old reliable vehicle has launched 122 spacecraft since 1994, of which 43 are Indian.

### Camera on PSLV filmed launch

Even as PSLV-C36 was coursing up its path, a video camera attached to it was filming the flight and sending down the images in real time.

The camera on the vehicle was among the few new parts the Indian Space Research Organisation tested in Wednesday's otherwise routine mission. "The [video] camera put on the launch vehicle showed us the deployment of [Resourcesat-2A] as well as the deployment of the solar panels," said A.S. Kiran Kumar, ISRO chairman. According to the director of launch centre Satish Dhawan Space Centre, P. Kunhikrishnan, and rocket complex Vikram Sarabhai Space Centre director S. Sivan, a few more new devices were tried out, including a remote fuel-filling system for the rocket's fourth stage, which cuts the countdown by a day and makes it safe for engineers working with propellants; a navigation processor and receiver based on the NAVIC navigation fleet guided the PSLV; a high performance avionics system and an indigenous Vikram processor; and an indigenous lithium ion power system for the first time in a PSLV.

### GSLV-Mk3 to fly on Jan. 20

GSLV-Mark 3, the country's most powerful launch vehicle built to lift the heaviest Indian communications satellites to space, is set for its first full-fledged flight on January 20, two ISRO directors announced .

Mk III can loft satellites weighing 4,000 kg to space, double the weight the current GSLV-Mk II can lift. "We are working to have the maiden test of GSLV-Mk3 flight on January 20," said S. Sivan of the Vikram Sarabhai Space Centre after the launch of Resourcesat-2A at Sriharikota. The vehicle will put the GSAT-19E communication satellite into orbit. When functional in a few years, Mk III will also enable ISRO to launch from India communications spacecraft to geostationary orbits of 36,000 km. Because of the absence of a powerful launcher, ISRO currently launches satellites above 2,000 kg on European rockets for a big fee. Mk III was partially tested in a 150-km 'sub-orbital' flight in December 2014, without the cryo engine. The smaller and now operational GSLV-Mk II will have its second flight soon. It will put GSAT-9 communications satellite into orbit.

### ISRO signs deal for first privately built satellite

The Indian Space Research Organisation has roped in a consortium of six companies to deliver the country's first industry-built spacecraft by late 2017.

The contract signed includes assembly, integration and testing (AIT) of two spare navigation satellites consecutively in around 18 months. It was signed between M. Annadurai, Director of ISRO Satellite Centre (ISAC), and the consortium lead; Alpha Design Technologies P Ltd. ISAC assembles the country's satellites for communication, remote sensing and navigation.

From the third year, Indian industry could expect competitive bids for a new lot of spacecraft of 300-500-kg class, perhaps five a year, for both ISRO and for export, Col. H.S. Shankar (ret'd), CMD of Alpha Design, told The Hindu. This is the first time that ISRO has outsourced an entire satellite to industry, said Col. Shankar .

Alpha is a defence manufacturing contractor while the others are small and medium-sized vendors that already supply components to ISRO. The others in the consortium are Newtech Solutions, Aidin Technologies and DCX Cables of Bengaluru, Vinyas Technologies of Mysuru and Avantel Systems of Hyderabad.

The work will start around January and the first spacecraft will be brought out in around nine months.

### NASA spots spider-shaped troughs on Mars

For the first time, scientists using data from NASA's Mars orbiter have imaged the growth of erosion-carved troughs that may be infant versions of Martian 'spiders' — radially patterned surface features found in the south polar region of the red planet.

Researchers using NASA's Mars Reconnaissance Orbiter (MRO) report the first detection of cumulative growth, from one Martian spring to another of channels resulting from the same thawing carbon-dioxide process believed to form the spider-like features.

The spiders range in size from tens to hundreds of metres. Multiple channels typically converge at a central pit, resembling the legs and body of a spider.

"We have seen for the first time these smaller features that survive and extend from year to year, and this is how the larger spiders get started," said Ganna Portyankina of the University of Colorado, Boulder in the U.S.

"These are sand dune areas, so we don't know whether they will keep getting bigger or will disappear under the moving sand," Mr. Ganna said.

Dunes appear to be a factor in how the baby spiders form, but they may also keep many from persisting through the





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centuries needed to become full-scale spiders.

The amount of erosion needed to sculpt a typical spider, at the rate determined from observing active growth of these smaller troughs, would require more than a thousand Martian years.

One Martian year lasts about 1.9 Earth years.

Carbon-dioxide ice, better known as “dry ice,” does not occur naturally on Earth. On Mars, sheets of dry-ice cover the ground during winter in areas near both poles, including the south-polar regions with spidery terrain. Dark fans appear in these areas each spring.

### NASA releases key software for free public access

NASA has made a range of software products publicly available, including codes for more advanced drones and quieter aircraft, which people can use for a wide variety of technical applications — without any royalty or copyright fees.

The 2017–2018 software catalogues has contributions from all the NASA’s centres on data processing, business systems, operations, propulsion and aeronautics.

It includes many of the tools NASA uses to explore space and broaden our understanding of the universe.

A number of software packages are being presented for release for the first time. Each catalogue entry is accompanied with a plain language description of what it does.

#### Aerospace applications

The catalogue includes the code LEWICE, developed to help study the effects of ice on an aircraft in flight and to create ice detection systems.

“The software catalogue is our way of supporting the innovation economy by granting access to tools used by today’s top aerospace professionals to entrepreneurs, small businesses, academia and industry,” said Steve Jurczyk, associate administrator for NASA’s Space Technology Mission Directorate in Washington.

“Access to these software codes has the potential to generate tangible benefits that create American jobs, earn revenue and save lives,” said Mr. Jurczyk.

NASA published the first edition of its software catalogue in April 2014, becoming the first comprehensive listing of publicly available software to be compiled by a U.S. federal government agency.

“Software has been a critical component of each of NASA’s mission successes and scientific discoveries. In fact, more than 30 % of all reported NASA innovations are software,” said Dan Lockney, technology transfer programme executive. “We’re pleased to transfer these tools to other sectors and excited at the prospect of seeing

them implemented in new and creative ways.”

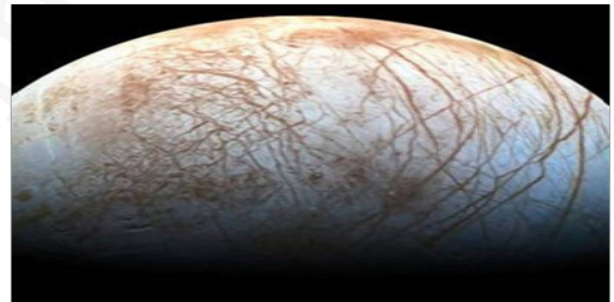
### NASA to explore Jupiter’s icy moon

NASA’s ‘Europa Clipper’ set to launch in the 2020s will probe the habitability of Jupiter’s icy moon Europa.

When the mission was still in the conceptual phase, it was informally called Europa Clipper, but NASA has now adopted that name as the formal title for the mission.

The moniker harkens back to the clipper ships that sailed across the oceans of Earth in the 19th century. The mission plan includes 40 to 45 flybys, during which the spacecraft would image the moon’s icy surface at high resolution and investigate its composition and the structure of its interior and icy shell.

Europa has long been a high priority for exploration because it holds a salty liquid water ocean beneath its icy crust.



#### Is it habitable?

The ultimate aim of Europa Clipper is to determine if Europa is habitable, possessing all three of the ingredients necessary for life: liquid water, chemical ingredients, and energy sources sufficient to enable biology.

“During each orbit, the spacecraft spends only a short time within the challenging radiation environment near Europa. It speeds past, gathers a huge amount of science data, then sails on out of there,” said Robert Pappalardo, Europa Clipper project scientist at NASA’s Jet Propulsion Laboratory in California.

### ‘Lost’ Chandrayaan-1 orbiting Moon: NASA

Chandrayaan-1 is very small and cuboid in shape, about 1.5 metres in length on each side. Although the interplanetary radar has been used to observe small asteroids several million miles from the earth, researchers were not certain that an object of this size could be detected as far away as the moon, even with the world’s most powerful radars.

Chandrayaan-1 proved the perfect target for demonstrating the capability of this technique.

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To find a spacecraft 380,000 km away, JPL's team used the 70-metre antenna at NASA's Goldstone Deep Space Communications Complex in California to send out a powerful beam of microwaves towards the moon. Then the radar echoes bounced back from lunar orbit were received by the 100-metre Green Bank Telescope in West Virginia.

JPL's orbital calculations indicated that Chandrayaan-1 is still circling some 200 km above the lunar surface, but it was generally considered "lost." However, the radar team utilised the fact that this spacecraft is in the polar orbit around the moon, so it would always cross above the lunar poles on each orbit.

On July 2 last year, the team pointed Goldstone and Green Bank at a location 160 km above the moon's north pole and waited to see whether the lost spacecraft crossed the radar beam. Chandrayaan-1 was predicted to complete one orbit around the moon every two hours and eight minutes. Something that had a radar signature of a small spacecraft did cross the beam twice during four hours of observations, and the timings between detections matched the time it would take Chandrayaan-1 to complete one orbit and return to the same position above the moon's pole.

The team used data from the return signal to estimate its velocity and the distance to the target. This information was then used to update the orbital predictions for Chandrayaan-1.

### **Mars may have had rings that it can possibly regain**

A new model developed by scientists at Purdue University in the U.S. suggests that debris that was pushed into space from an asteroid slamming into Mars around 4.3 billion years ago alternates between becoming a planetary ring and clumping together to form a moon.

According to one theory, Mars' large North Polar Basin or Borealis Basin — which covers about 40% of the planet in its northern hemisphere — was created by that impact, sending debris into space.

"That large impact would have blasted enough material off the surface of Mars to form a ring," researcher Andrew Hesselbrock said.

#### **Moon formed**

As the ring formed, and the debris slowly moved away from the planet and spread out, it began to clump and eventually formed a moon.

Over time, Mars' gravitational pull would have pulled that moon towards the planet until it reached the Roche limit,

the distance within which a planet's tidal forces will break apart a celestial body that is held together only by gravity.

#### **In 70 million years**



Phobos, one of Mars' moons, is getting closer to the planet. According to the model, Phobos will break apart upon reaching the Roche limit, and become a set of rings in roughly 70 million years.

Depending on where the Roche limit is, Mr. Hesselbrock and David Minton believe this cycle may have repeated between three and seven times over billions of years. Each time a moon broke apart and reformed from the ring, its successor moon would be five times smaller than the last.

### **Gravitational waves jettison black hole**

NASA's Hubble space telescope has detected a super-massive black hole that has been kicked out of the centre of a distant galaxy by what could be the power of gravitational waves.

Weighing more than one billion suns, the rogue black hole is the most massive black hole ever detected to have been kicked out of its central home.

Researchers estimate that it took the equivalent energy of 100 million supernovas exploding simultaneously to jettison the black hole.

The most plausible explanation for this propulsive energy is that the monster object was given a kick by gravitational waves unleashed by the merger of two hefty black holes at the centre of the host galaxy, according to the scientists.

Hubble's observations of the black hole surprised the research team. "When I first saw this, I thought we were seeing something very peculiar," said team leader Marco Chiaberge of the Space Telescope Science Institute (ST-ScI) and Johns Hopkins University, in Baltimore, Maryland, U.S.

"When we combined observations from Hubble, the Chandra X-ray Observatory, and the Sloan Digital Sky Survey, it all pointed towards the same scenario," said

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Mr. Chiaberge.

Hubble images taken in visible and near-infrared light provided the first clue that the galaxy was unusual.

#### **Bright quasar**

The images revealed a bright quasar, the energetic signature of a black hole, residing far from the galactic core. Black holes reside in the centre of galaxies, so it's unusual to see a quasar not in the centre," Mr. Chiaberge added. The team calculated the black hole's distance from the core by comparing the distribution of starlight in the host galaxy with that of a normal elliptical galaxy from a computer model.

The black hole had travelled more than 35,000 light years from the centre, which is more than the distance between the sun and the centre of the Milky Way, according to the study.

First predicted by Albert Einstein, gravitational waves are ripples in space that are created when two massive objects collide. The ripples are similar to the concentric circles produced when a hefty rock is thrown into a pond.

#### **Comet 45P's closest encounter with Earth**

Comet hunters have a chance to spot comet 45P/Honda-Mrkos-Pajdusakova in the next few days using binoculars or a telescope, NASA said on Saturday.

"It's the first of a trio of comets that will, between now and the end of 2018, pass close enough to Earth for backyard observers to try to spot and for scientists to study using ground-based instruments," the U.S. space agency said.

The recommendation for backyard astronomers is to use binoculars or a telescope to look for the comet several times during the coming days, NASA said.

It's named Comet 45P/Honda-Mrkos-Pajdušáková after the astronomers who discovered it in 1948: Minoru Honda, Antonín Mrkos, and Ludmila Pajdušáková. 45P is a short-period comet, with an orbit that takes it around the Sun and out by Jupiter about every 5-1/4 years. This weekend's encounter will be the comet's closest with Earth, passing by at a distance of about 12.4 million kilometres, through the end of this century.

The comet will pass by our planet again in 2032 but will be much farther away — at a distance of nearly about 48 million kilometres. Scientists have taken advantage of 45P's approach, making observations using powerful ground-based telescopes such as NASA's Infrared Telescope Facility to investigate the gases, dust and ice particles that are released from the comet nucleus and show up in the coma and tail.

By looking for water, methane and other compounds, astronomers get clues about how the comet is put together and where it originated in the cloud of material that surrounded the young sun as the solar system formed.

By observing the same comet more than once, astronomers can see how the object changes over time. "Observing a comet multiple times over successive orbits is like taking snapshots at different stages of life," said Joseph Nuth, a senior scientist at NASA's Goddard Space Flight Center in Greenbelt, Maryland.

NASA said ground-based observations also are planned for comet 41P/Tuttle-Giacobini-Kresak, which will pass closest to Earth on April 1, and for comet 46P/Wirtanen, passing closest to Earth on December 16, 2018.

By studying this trio of comets, astronomers can learn more about the differences between comets — information they use to fill in the comet family tree.

#### **Telescope upgrade to sniff out solar storms**

The GRAPES-3 experiment at TIFR's Cosmic Ray Laboratory in Ootacamund is getting upgraded. The telescope made news last year when it detected the effect of a solar storm that hit the earth in June 2015. The upgrade will play a major role in getting precise information about the propagation of storms in 'the last million miles' (from the L-1 point) of their journey from the Sun to the earth.

The upgraded detector will have an increased coverage of the sky and improved capacity to determine the direction of incident cosmic rays. The latter property, of being able to discern the direction of detected particles, makes it unique among cosmic ray detectors in the world; it can also to measure the intensity of the particles. Since the enhanced facility can cover a wider field of view (from present 37% to 57%), the chances of spotting solar storms will be higher.

The sun is at a distance of 150 million kilometres from the earth, and satellites have been placed at a distance of nearly 1.5 million kilometres, at the so-called L1 point, where they orbit the Sun along with the Earth. Since charged particles from a solar storm will first impact the satellites before hitting the earth, they act as an early warning system. Depending on the speed of the storm, it will take about 20-40 minutes to reach the earth from the L1 point.

However, the GRAPES-3 may differ from the satellite estimates of the travel time. This is what Sunil Gupta, Head of the GRAPES-3 experiment, terms traversing the 'last million miles'. He says: "GRAPES-3 has an important



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role in understanding the propagation of storms from the L1 point to its impact on the Earth. We have seen indications that the actual time taken may not be what the satellites predict.”

#### **Taking preventive steps**

It is important to know the time when plasma will reach the earth, accurately, so that preventive and protective measures can be put into place in case a solar storm was to strike the earth.

If the earth’s magnetic field were to be weakened by extreme solar storms, charged particles would shower on to the planet. Apart from rendering electronic devices defunct, charged particles in an extreme solar storm can also short current carrying over-head high voltage lines, leading to large-scale transformers burn out and thereby, power blackouts. A 2008 study conducted by the U.S. National Academy of Sciences estimated that an extreme event could lead to a loss of 40% of transformers in the U.S., which, in turn, could take years to restore.

The up side is that the way to prevent such a disaster is well understood: simply switch off the power lines on being informed of an approaching solar storm! And for this to be possible, an accurate determination of the time taken for the solar storm to travel to the earth is needed, which is where the GRAPES-3 set up comes in.

#### **5 new satellites this year to raise ISRO capacity**

An unprecedented row of five national communication spacecraft is slated to be put in space this year with hopes of vastly cutting the gap in satellite capacity for different users.

The first of them, GSAT-9 or the South Asia Satellite, will kick off the serial launches in the first half of April from the Sriharikota space port. (Officials said they had not yet set a date for it.)

#### **‘Perceptible change’**

A.S. Kiran Kumar, Chairman of the Indian Space Research Organisation, recently told The Hindu: “This year we are launching with five more communication satellites. With all of them coming up, there will definitely be a drastic, perceptible change in satellite capacity. In a matter of one year, the scene should be much better than what it is.”

Mr. Kumar also said the ISRO has been taking conscious action to improve its overall communication transponders capacity; this space infrastructure supports broadcasters, telephone, Internet service and other businesses. New satellites that are constantly put up for approval

could ease up the scene in the next two to three years, he said.

For several years now, the space agency has been beset with a capacity deficit, caused by launch failures in which satellites were destroyed; and a galloping demand from public and private sector users.

The agency says its communication fleet of 14 provides 200-odd transponder equivalents. Other 95-odd transponders have been hired on foreign satellites to support Indian direct-to-home broadcasters and the agency aims to bring them back to its satellites.

Referring to last year’s success and regularisation of the GSLV Mark-II rocket programme — that can put up to 2,000-kg satellites to space — Mr. Kumar said:

“We have overcome some of the issues of launch vehicles, now we need to produce and make more use of them, and put more satellites into orbit.”

#### **GSAT-9 will ride on one such indigenous GSLV.**

Historic and a rarity

Five communication spacecraft spread over less than a year is historic and a rarity for ISRO; all these years, it has launched one or two communication satellites a year. GSAT-18 was the lone communication satellite sent up in late 2016.

Tentatively, ISRO has lined up the Internet user-friendly GSAT-19 for launch around May; GSAT-17 around June; GSAT-6A, which like GSAT-6, is for the Defence forces, in September; and its largest 5,000-plus GSAT-11 around December. GSAT-17 and GSAT-11 will be launched on the European Ariane launcher.

After INSAT-4CR was moved to a new orbital slot a few months ago, its efficiency has been improved and a little extra capacity created for select use, he said.

#### **NASA’s Mars probe completes 50,000th orbit**

NASA’s Mars Reconnaissance Orbiter (MRO) has completed its 50,000th orbit this week, continuing to compile the most sharp-eyed global coverage ever accomplished by a camera at the Red Planet.

The orbiter continues diverse science observations of Mars and communications relay service for two active Mars rovers, Curiosity and Opportunity.

MRO’s Context Camera (CTX) exploits a sweet spot in the balance between resolution and image file size.

With a resolution of about six metres per pixel in images of the Martian surface, it has provided a library of images





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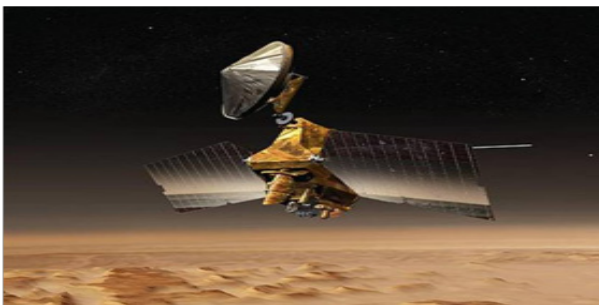
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now covering 99.1 per cent of Mars. That is about equivalent to the land area of Earth. No other camera ever sent to Mars has photographed so much of the planet in such high resolution.



The Camera has taken about 90,000 images since the spacecraft began examining Mars from orbit in late 2006. Each one reveals shapes of features down to sizes smaller than a tennis court, in a swath of ground about 30 kilometers wide.

“Reaching 99.1% coverage has been tricky because a number of factors, including weather conditions, coordination with other instruments, downlink limitations, and orbital constraints, tend to limit where we can image and when,” said Michael Malin, Context Camera Team Leader of Malin Space Science Systems in the US.

In addition to observing nearly the entire planet at least once, the Context Camera has observed 60.4 per cent of the planet more than once. These observations aid science directly and also certify the safety of future landing sites.

“Single coverage provides a baseline we can use for comparison with future observations, as we look for changes,” Malin said.

### In ISRO's launch of 104 satellites next week, 88 will be from U.S.

The Indian Space Research Organisation (ISRO) is on the cusp of making history when it sends 104 satellites into orbit on its PSLV-C37 rocket on February 15. Only three of them are Indian satellites.

Notably, in ISRO's first mission of 2017, a single U.S. Earth imaging company, Planet, has made an eye-popping bulk booking for 88 of its small ‘cubesats’.

No space agency has launched such a large number of satellites in a single flight so far. (While ISRO's PSLV launched 20 satellites last year, Russia's Dnepr launcher holds the record for lifting 37 satellites to orbit in June 2014.)

The PSLV will carry a main remote-sensing satellite in the Cartosat-2 series and two small spacecraft, all for ISRO,

and 101 small foreign commercial satellites.

The 88 cubesats are part of Planet's earth observation constellation of 100 satellites. They weigh around 5 kg each and are called ‘Doves’ or Flock 3p. For California-based Planet, too, it will be the record largest number of cubesats to be flown in a single launch, according to one of its executives.

Planet, an earth observation company formed in 2010 by former NASA scientists, has chosen ISRO's PSLV launch for the second time. It got its earlier set of 12 ‘Doves’ launched in June last year.

### Cartosat-2 & INS-1

The main passenger on PSLV-C37 will be the fourth in the Cartosat-2 series, a very high resolution Earth observation satellite of about 650 kg, and occupies roughly half the space in the launch vehicle. It will carry two more Indian nano satellites, INS-1A and INS-1B, each weighing about 10 kg. They have a short lifespan of six to 12 months.

All the payloads will totally weigh around 1,500 kg, according to an ISRO official who did not want to be named. The 88 Doves would be released in sets of four cubesats. The other co-riders are cubesats or small specialised satellites of customers from Israel, the UAE, Kazakhstan, the Netherlands, Belgium and Germany. They will be released separately into their orbits at around 500 km from Earth. While ISRO has been cagey about giving details of its customers,

Planet's executive Mike Safyan announced, “In February, we are launching 88 satellites — the largest fleet of satellites launched in history. The Dove satellites, collectively known as “Flock 3p,” will ride aboard a PSLV rocket from the Satish Dhawan Space Centre in Sriharikota, India.”

### Biggest launch

“This is the 15th time Planet is launching Dove satellites; and it will be our biggest launch to date. Combined with the 12 satellites of Flock 2p operating in a similar orbit, this launch will enable Planet's 100-satellite ‘line scanner’ constellation of Doves,” Mr. Safyan said.

Since September 2015, the PSLV has launched 18 small U.S. earth imaging satellites in a total of 79 foreign spacecraft — which earns it some revenue and an increasing global market share.

The Planet series comes even as COMSTAC, (Commercial Space Transportation Advisory Committee under the U.S. FAA) is considering if U.S. satellites can be sent to space on Indian launchers. Sources said PSLV's U.S. clients were being approved on individual basis.





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### ISRO on verge of 104-satellite launch feat

The launch of 104 satellites on a single PSLV mission is keeping the space community agog.

The entire flight of the PSLV-C37 rocket takes nearly 29 minutes, just four minutes longer than a regular PSLV that may carry one or two satellites.

Some 17 minutes into flight, and in an eye-popping feat, the first and the last satellite will all be out in space within 11 minutes — a record that is expected to put the scientists and engineers of the Indian Space Research Organisation in the spotlight.

ISRO has scheduled the launch for 9.28 a.m. on February 15 from the Satish Dhawan Space Centre (SDSC) at Sriharikota in coastal Andhra Pradesh. To date, the highest number of satellites, 37, in a single mission was made in June 2014 by a Russian Dnepr rocket.

Of the 104 on the PSLV, 96 satellites belong to two U.S. customers: 88 Doves with Planet Labs and eight LEMURs with Spire Global Inc. ISRO chairman A.S. Kiran Kumar, who has said ISRO is not after making any record, was recently reported as saying that half the cost of the PSLV was covered by launch fees from the seven customers. A PSLV is estimated at around Rs. 200 crore. The rocket will release the first passenger, Cartosat-2 series, about 17 minutes after lift-off. The last satellite will be out by 29th minute, all neatly out of each other's way. The commercial payloads will be released a minute after Indian satellites. All satellites are programmed to come out in a sequence of singles or doubles.

Two earlier rockets, also in the extended XL format, have carried ten and 20 satellites to space. However, the current PSLV-C37 is "mission intensive" as it carries five times the number it did in June 2016, according to PSLV Project Director B. Jayakumar of the Vikram Sarabhai Space Centre. The VSSC based in Thiruvananthapuram is the main centre for ISRO's launchers.

#### **Meticulous planning**

Preparations for the mega release began about six months ago, with meticulous detailing of the sequence of release for each of the 104 satellites into space.

Mr. Jayakumar said the main consideration was the safety of all the satellites in orbit after release. "The task before us was to separate them in a non-colliding manner. A minimum gap should be ensured between releases. A few innovative approaches had to be studied and implemented for this mission," he told The Hindu.

Accommodation of all the satellites within the space available in the last and fourth stage of the rocket was

another daunting task; it was handled by using customised components called adapters.

### ISRO's workhorse lives up to its billing

The PSLV, which created launch history by placing a record 104 spacecraft in their desired orbits, has totally launched 46 Indian spacecraft, most of them Indian Remote Sensing (IRS) satellites.

As many as 180 small satellites of foreign customers contracted by ISRO's commercial company Antrix Corporation have also reached space on this vehicle.

The PSLV, 39 flights old since 1993, also launched the Indian Moon mission Chandrayaan-1 in 2008; and is set to launch a private lunar mission for Bengaluru start-up Team Indus in late December this year.

"It is confirmed that all 104 satellites have been successfully deployed in the orbit," PTI quoted PSLV Project Director B. Jayakumar at the Vikram Sarabhai Space Centre (VSSC) as saying.

"After separation, the two solar arrays of Cartosat-2 series satellite were deployed automatically and ISRO Telemetry, Tracking and Command Network (ISTRAC) at Bengaluru took over the control of the satellite," the space agency said.

In the coming days, the satellite will be brought to its final operational configuration. Thereafter, its panchromatic (black and white) and multi-spectral (colour) cameras will start giving remote sensing services.

Two Indian co-passengers are technology demonstrators: ISRO Nano Satellite-1 (INS-1) weighing 8.4 kg and INS-2 weighing 9.7 kg.

Of the 101 foreign co-passengers, 96 came from two U.S. customers; and one each from the Netherlands, Switzerland, Israel, Kazakhstan and the UAE.

Planet Labs, a U.S. Earth observation company, alone sent up 88 of its roughly 5-kg cubesats on this vehicle.

ISRO Chairman A.S. Kiran Kumar told PTI: "Now we are targeting [the bigger launchers] GSLV MarkII and then Mk III. A series of launch activities are planned this year also."

### Why Earth's inner core doesn't melt

Scientists have discovered why the crystallised iron core of the Earth remains solid, despite being hotter than the surface of the Sun.

Researchers at the KTH Royal Institute of Technology in Sweden found that on the edge of the inner core, pieces of crystals' structure continuously melt and diffuse only to be reinserted due to high pressure like "shuffling deck of cards."



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This energy distribution cycle keeps the crystal stable and the core solid.

Spinning within Earth's molten core is a crystal ball — actually a mass formation of almost pure crystallised iron — nearly the size of the moon.

Understanding this strange, unobservable feature of our planet depends on knowing the atomic structure of these crystals — something scientists have been trying to do for years.

As with all metals, the atomic-scale crystal structures of iron change depending on the temperature and pressure the metal is exposed to.

Atoms are packed into variations of cubic, as well as hexagonal formations. At room temperatures and normal atmospheric pressure, iron is in what is known as a body-centred cubic (BCC) phase, which is a crystal architecture with eight corner points and a centre point.

However at extremely high pressure, the crystalline structures transform into 12-point hexagonal forms, or a close packed (HCP) phase.

At Earth's core, where pressure is 3.5 million times higher than surface pressure — and temperatures are some 6,000 degrees higher — scientists have proposed that the atomic architecture of iron must be hexagonal.

Anatoly Belonoshko from KTH said data showed that pure iron likely accounts for 96% of the inner core's composition, along with nickel and possibly light elements.

#### **Temperature impact**

At low temperature, BCC is unstable and crystalline planes slide out of the ideal BCC structure. But at high temperatures, the stabilisation of these structures begins much like a card game — with the shuffling of a “deck.”

Mr. Belonoshko said in the extreme heat of the core, atoms no longer belonged to planes because of the high amplitude of atomic motion.

“The sliding of these planes is a bit like shuffling a deck of cards. Even though the cards are put in different positions, the deck is still a deck. Likewise, the BCC iron retains its cubic structure,” he said.

Such a shuffling leads to an enormous increase in the distribution of molecules and energy — which leads to increasing entropy, or the distribution of energy states.

That, in turn, makes the BCC stable, he said.

#### **For ex-ISRO scientist, 23 years of struggle**

As the Indian Space Research Organisation (ISRO) conquers space in leaps and bounds, one of its old hands,

S. Nambi Narayanan, has been haunting the Supreme Court corridors for the past two years seeking justice against police officers who allegedly framed him in the infamous 1994 spy scandal.

#### **Bench's decision**

, a Bench of Justices Dipak Misra, R. Banumathi and Ashok Bhushan decided that the 76-year-old Narayanan has waited long enough. The Bench refused a plea for four weeks' adjournment made by Mr. Narayanan's rivals in court. Justice Misra scheduled the case for final hearing on February 24.

Mr. Narayanan has sought criminal action against former Kerala ADGP Sibi Mathew, K.K. Joshwa and S. Vijayan — both had retired in senior positions in the police — for their alleged roles.

“It has been a long road to justice,” Mr. Narayanan, who stays in Thiruvananthapuram in Kerala, said outside the courtroom. He is visibly relieved that the case was not adjourned.

It has been 23 years since his legal battle began with his arrest in the scandal.

His counsel, advocates C. Unnikrishnan, calls his client an “investigator.” “While the others gave up, he did not,” the lawyer said.

Mr. Narayanan, one of the scientists who had worked on the cryogenic engine, was arrested in the espionage case in November 1994. The CBI, which got the case from the State Special Investigation Team, had recommended its closure and sought action against the police officers involved, Mr. Narayanan said in his petition.

#### **NHRC order**

The National Human Rights Commission, in March 2001, had ordered the government to pay Mr. Narayanan Rs. 10 lakh compensation for the mental agony, torture and social stigma he suffered.

A decade after the NHRC order, the government issued a Government Order in June 2011 closing the case against the police officers, saying they have retired and 13 years have passed since the arrest of Mr. Narayanan.

Subsequently, a Division Bench of the Kerala High Court, in March 2015, set aside a Single Judge order to take action against the police officers. Mr. Narayanan appealed against the Division Bench decision in the Supreme Court.

In July 2015, a Bench issued notice on Mr. Narayanan's appeal seeking action against the police officers.

The Supreme Court had said the spy case fundamentally pertained to police atrocities. The court had pulled up the



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Kerala government for not taking any action against “erring” police officials for the illegal arrest of Mr. Narayanan. Outside the courtroom, Mr. Narayanan’s conversation trails away from his case and a faint smile crossed his face as one of the journalists queried about the ISRO’s record launch recently.

### **NASA to reveal stirring exoplanet findings**

NASA has hinted at discovery of something exciting related to planets that orbit stars other than our sun, known as exoplanets.

The U.S. space agency said it will hold a news conference to present the findings at the agency’s headquarters in Washington.

Prominent NASA scientists, astronomers and a professor of planetary science and physics at Massachusetts Institute of Technology are scheduled to participate at the briefing.

#### **Open to questions**

NASA has also invited media and is open to the public to ask questions during the briefing on Twitter using the hashtag #askNASA.

Following the briefing, a Reddit AMA (Ask Me Anything) about exoplanets will be held with scientists available to answer questions in English and Spanish, NASA said. Details of these findings will also be published in the journal *Nature* on the same day.

### **7 Earth-like planets spotted**

Low temperatures make possible the presence of liquid water on their surface

Scientists have spotted seven Earth-sized planets, with mass similar to Earth, orbiting around a dwarf star the size of Jupiter, just 39 light years from the Sun. The planets’ temperature is low enough to make possible the presence of liquid water on their surface.

In May last year, scientists found three planets passing in front of TRAPPIST-1, the dwarf star. Based on further monitoring of the star from the ground and space, scientists have found four more ‘exo-planets’ orbiting TRAPPIST-1. The results are getting published (February 23) in *Nature*. Michaël Gillon from the Université de Liège, Belgium is the first author of the paper.

#### **Habitable zone of star**

“This is the first time we have so many Earth-like planets found around a star. The star is low-mass and small,” Dr. Gillon said during a press briefing. “The seven stars could have some liquid water and maybe life. These planets

are found in the habitable zone of the star. This is the first time we have found so many planets in the habitable zone of a star.”

The scientists have been able to make precise mass measurement for six of the seven planets. Though the mass measurements are preliminary, they do indicate that the planets are terrestrial with liquid water. “The seven planets are suitable for detailed atmospheric study,” said Dr. Gillon. “The architecture suggests that the seven planets formed farther from the star and migrated towards the star.”

“We can study the climate and chemical composition of the planets’ atmosphere,” Dr. Amaury H.M.J. Triaud from the Institute of Astronomy, Cambridge, one of the authors of the paper, said during the briefing. “We are first trying to rule out the presence of large hydrogen envelope to make sure that the planets are indeed Earth-like. These will be followed by detailed study of climate and chemical composition to try and find out if there is life on these planets. If there is life on these planets we will know it in a decade.”

#### **Orbital periods**

The four newly discovered planets orbit around the star every 4.04 days, 6.06 days, 8.1 days and 12.3 days respectively; the orbital period of two of the three planets discovered last year is 1.51 days and 2.42 days respectively.

Five planets have sizes similar to that of the Earth, while the remaining two are intermediate in size — between Mars and Earth. Based on the mass estimates, the six inner planets may have a rocky composition. The sixth planet has low density suggesting a volatile rich composition. The volatile content could be either ice layer and/or atmosphere.

### **Rare luminous nebula poses cosmic puzzle**

Astronomers have spotted an enormous, glowing blob of gas in the distant universe, with no obvious source of power for the light it is emitting.

Called an “enormous Lyman-alpha nebula” (ELAN), it is the brightest and among the largest of these rare objects, only a handful of which have been observed, the researchers said.

The newly discovered nebula was found at a distance of 10 billion light years in the middle of a region with an extraordinary concentration of galaxies.

Researchers found this massive overdensity of early galaxies, called a “protocluster,” through a novel survey pro-



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ject led by Zheng Cai, Hubble postdoctoral fellow at University of California, Santa Cruz, in the U.S. "Our survey was not trying to find nebulae. We're looking for the most overdense environments in the early universe, the big cities where there are lots of galaxies," said Mr. Cai, who is first author of a paper on the discovery to be published in the *Astrophysical Journal*. "We found this enormous nebula in the middle of the protocluster, near the peak density," Mr. Cai said. The newly discovered ELAN is known as MAMMOTH-1.

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## ATOMIC ENERGY

### A novel electrode for lithium batteries

A team of researchers at the Indian Institute of Technology (IIT) Madras have been able to enhance the capacity retention of anode material in lithium ion batteries four-fold compared to commercially available lithium batteries. The team was able to develop a novel composite that can deliver specific capacity retention of 1,120 mAh/g after 10,000 cycles, and work at high current density (ability to draw more current from a cell within a short time) with long cycle life by combining two types of lithium ion storage mechanisms. The results were published in the Journal of Materials Chemistry A.

Compared with graphite, carbon nanotube (CNT) has several advantages as an anode material. However, the efficiency (or irreversible capacity) of carbon nanotube anode is an issue. Also, the lithium ions that get inserted into the carbon nanotube during charging do not fully come out during discharge. So not all lithium ions inserted into carbon nanotube comes out to contribute to the useful capacity.

"We overcame this by using carbon nanotubes with a few layers unzipped, which can be called as partially exfoliated carbon nanotubes," says Sripada Raghu from the Department of Physics, IIT Madras and one of the authors of the paper. The unzipping does not affect the core of the CNT structure, which renders very good electrical conductivity, while the partially exfoliated out layers have very good ability to store lithium ions.

"The outer layers of partially exfoliated carbon nanotubes are quite similar to a few-layered graphene," says Mr. Raghu. To enhance the capacity even further, the researchers incorporated sulphur in the exfoliated layers. The theoretical capacity of sulphur is very high (1,675 mAh/g). So the team wanted to take advantage of this property of sulphur.

#### **Mechanisms clubbed**

Besides getting inserted into the layers of exfoliated carbon nanotube, the lithium ions interact with sulphur in a chain of reactions, leading to the formation of lithium polysulphides. Higher-order polysulphides are initially formed and later the stable lower-order polysulphides are formed.

"The lower-order polysulphides are desirable," says Ananya Gangadharan from the Department of Physics, IIT Madras and the first author of the paper.

"We have clubbed the two storage mechanisms — lithium ion insertion reaction from the lithium ion battery and sulphur redox reaction from the lithium sulphur battery — in one battery. That's why we are able to achieve high capacity retention even after 10,000 cycles at high current density," says Ms. Gangadharan.

"We have already patented our anode material. We are now trying to combine the anode with suitable cathodes and test the enhancement in efficiency and capacity retention so we can replace the commercial anodes with ours," says Prof. Sundara Ramaprabhu from the Department of Physics, IIT Madras and the corresponding author of the paper.

"Work is currently on to further enhance the capacity and use the material as an electrode in both lithium ion and lithium sulphur batteries," he said.

### Now, a cheap way to produce nuclear fuel using electricity

Scientists in Russia have developed a unique, low-cost method for producing high-quality nuclear fuel using electricity.

The main type of fuel for nuclear power reactors is the uranium oxide pellet composition, said Ivan Tananaev, from the Far Eastern Federal University School of Natural Sciences. It is produced from a powder by granulation, pressing, and sintering (coalescing into a solid or porous mass by heating) with the subsequent control of the quality and size of the pellets.

#### **Powder metallurgy**

The new technology allows one to obtain products that are of high quality and to reduce the number of production stages without increasing the cost.

The researchers have proposed an alternative mode of production, which forms the basis of powder metallurgy: electric pulse sintering under pressure.

"The key idea of our method is heating by an electric current passing through the mould with the powder placed in it," said Mr. Tananaev.

Nod for uranium exploration proposal in Amrabad tiger reserve

A proposal for uranium exploration in the Amrabad Tiger Reserve has been cleared by the Telangana State Board for Wildlife, paving the way for mining of the subterranean element used in nuclear reactors and in production of nuclear weapons.

Proposal for exploration of the element in Amrabad reserve was tabled for discussion in the first ever meeting of the Board, which was chaired by Forest Minister Jogu Ramanna, here. The proposal was cleared unanimously

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by the Board, with not much opposition even from the independent members, sources informed. However, it was agreed that the exploration should be preceded by a visit by team from the National Tiger Conservation Authority (NTCA). The Board met for the first time in two years after it was reconstituted, post the bifurcation.

The proposal by the Regional Director of South Central Region of the Department of Atomic Energy (DAE) sought permission for uranium exploration survey over 83 square kilometres of the forest area falling in Amrabad Tiger Reserve which is spread over Amrabad and Udumilila in Mahabubnagar district and Narayanpur in Nalgonda district. Uranium exploration in the reserve has been a contentious issue right since early this millennium, when the same was proposed by the DAE. Environmentalists rose up against the mining proposal, resulting in the State Pollution Control Board vetoing it despite approval from the National Board of Wildlife.

The issue resurfaced when aerial reconnaissance was conducted a few years ago, to locate the uranium-rich regions in the reserve, giving rise to vocal protests by adivasis and environmentalists. After approval by the State Board, the proposal will now be sent to the National Board of Wildlife (NBWL). Another major proposal that was cleared at the meeting was to allow movement of heavy vehicles through Kawal Tiger Reserve during day time. Other proposals included notification of the nesting and breeding area of Long Billed Vultures in Bejjur range of Kagaznagar division as conservation reserve, and diversion of forest areas for Mission Bhageeratha project.

### 'Nanoceramic' material for safer, cheaper nuclear reactors

Scientists, including one of Indian origin, have created a nanoceramic material, which may be used in next-generation nuclear reactors that will operate at higher temperatures and radiation fields, producing energy more efficiently and economically.

#### Tougher under radiation

The material can not only withstand the harsh effects of radiation, but also becomes tougher under radiation, researchers said.

Traditionally, water has been used as the primary coolant in reactors, absorbing the heat released from fission reactions.

Though water poses fewer risks of corrosion damage to materials, there are also limits to the temperatures up to which water-cooled reactors can operate — and in advanced reactors, increasing their temperature is the best

way to increase energy production.

New coolants, such as liquid metals like sodium and lead, are effective at much higher temperatures, but also are much more corrosive to the materials from which a nuclear reactor is made. "There is a preferred use of metallic materials for structural components, but many of these materials cannot withstand high-temperature corrosion in advanced reactors," said Kumar Sridharan, professor at the University of Wisconsin-Madison in the U.S.

The research was published in the journal Scientific Reports.

### Clearance for Neutrino project suspended

"The claim is that the site is within 4.9 km of the Madhiket-tan Shola Natural Park. This is very close to the guideline limit of 5 kilometres. So we have to verify that the project actually falls within this distance. If it does, we will surely get the clearance as instructed. We have no intention of flouting any rules," said D. Indumathi, Spokesperson of the INO, Faculty at the Institute of Mathematical Sciences.

Sekhar Basu, Chairperson of the Department of Atomic Energy said that as he had not seen the judgment, he could not comment. He, however, added that if the INO cannot come up anywhere in India, the people would just lose in terms of science.

Dr. Basu also dismissed fears that there was a plan to store nuclear waste in the tunnels of the INO. "It is really a pity that such a fear exists, and it is a story without a basis," he said.

Dr. Indumathi also said, "The judge has requested to conduct the case expeditiously. So we are hopeful that things will move quickly now."

### Chennai scientists show a breakdown of the Standard Model

The search for physics beyond the Standard Model which until now has explained all interactions between the elementary particles is an important area of research. Now, there is evidence that the Standard Model is not a complete description of the microscopic world of elementary particles.

Scientists at Institute of Mathematical Sciences (IMSc), Chennai, have come up with a calculation based on the observations made at the LHCb (Large Hadron Collider beauty) experiment at CERN, which shows definitively that in a specific interaction, the standard model predictions are violated and there is indirect evidence of new



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physics. The research is published in the journal Physical Review D.

#### **Suppressed reaction**

The interaction that has been studied involves the decay of the B meson into a lighter boson called the vector-Kaon meson and a pair of muon (a heavier cousin of the electron) and its antiparticle. The process is interesting as it involves a change in a quantum number known as “flavour” without the change of charge.

The process can happen only because of the quantum nature of elementary particles and involves virtual creation of heavier particles for a very short time — a process known as the loop diagram.

It is known that loop processes themselves are very tiny in relation to louder signals from more dominant processes. Flavour-changing loop processes like this one are further suppressed because of the nature of flavour-changing neutral current involved. Because of this weakness of the signal, the process is sensitive to violation of the Standard Model.

Rusa Mandal and Rahul Sinha of IMSc, Chennai, have pointed out the precise discrepancy that shows up when the theoretical calculation based on the Standard Model is compared with the precise experimental observations from the LHCb at CERN.

#### **First mooted**

“It was at IMSc in 1996 and 1999 that we first showed how this mode would allow a plethora of related observables to be measured allowing for a very sensitive search for new physics,” says Dr. Sinha. “Today, the study of this mode attracts the most attention among physicists studying flavour-changing loop processes and is a focus at all major high energy physics conferences in the world.”

When asked to comment on this work, Prof. S Umasankar from IIT Bombay, who is not part of this group, said: “This is an important result resting on the premise that the present consensus on theoretical understanding is correct. The only previous result looked at a different variable and found a discrepancy at 4-sigma.

In this paper, the authors have obtained a difference that is more than 5 sigma in a large number of cases. It is a result that both theoreticians and experimentalists should scrutinise with utmost seriousness.”

Identification of this mode of decay as the one that would show up new physics has resulted in many physicists around the world studying it. While other groups have also been pursuing this line, the approach of the IMSc group has nearly eliminated all hadronic uncertainties.

The researchers are now working on a paper that outlines more clearly the exact nature of the new physics

involved.

#### **IIT Bombay: Chennai and Mumbai have high wind energy potential**

Of the six cities studied by Indian Institute of Technology, Bombay researchers, Chennai and Mumbai seem to have the highest potential to harvest wind energy during the time when the wind energy potential is very high (active period) during the monsoon period. Compared with these two cities, Indore, Ahmedabad and Kolkata have less potential to harvest wind energy; Delhi has the least potential. The results were published in the journal Meteorology and Atmospheric Physics.

The researchers studied the strength of southwest wind during the time of the monsoon and called the period when the wind energy potential is high, the active period and the period when the wind energy potential is low, the break period. The high wind energy potential during the active period also coincides with more rainfall; there is less rainfall and less wind energy potential during the break period.

“The idea behind the study was know what the implications of the active and break periods would have on energy demand scenario in the major cities,” says Prof. Subimal Ghosh from the Department of Civil Engineering, IIT Bombay, and one of the authors of the paper.

“We have not studied the impact of climate change on wind power in the six cities. Though we have studied both active and break periods, the focus of the work was on studying the impact of dry spells [break periods] during the monsoon on energy demand-supply,” says Prof. M.C. Deo from the Department of Civil Engineering, IIT Bombay, and one of the authors of the paper.

“Our study tries to answer the question if possible extraction of wind energy in the six cities can be relied on to meet the additional power demand during prolonged dry spells in the monsoon season.”

“Amongst the six cities we have considered, Mumbai and Chennai have high wind energy potential, as there is strong wind because of their coastal location. Wind energy extraction in these two cities can be of great help in meeting the gap between power demand and supply from conventional sources. The cities of Indore, Delhi and Ahmedabad do not have this advantage and hence would be unable to meet such gap in demand-supply during the dry spells in monsoon,” says Prof. Deo.

Mumbai and Chennai have predominantly higher-than-average wind energy potential during the active period compared with the break periods. “Being coastline cities, the surface drag exerted in the wind flow is the least. Also,

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these two cities are predominantly closer to the onset locations of southwest monsoon winds. So the prospects at these two cities are brighter,” says Sumeet Kulkarni from the Department of Civil Engineering, IIT Bombay, and the first author of the paper.

In the case of Delhi, besides that the likelihood of wind energy potential being above average is much less, a large number of high-rise buildings further dampens the prospects of efficient wind energy extraction.

It was observed that wind energy supply in north and south India has an opposing relation during the active and break periods.

For instance, during active phases, when the expected mean temperature is on the lower side, vigorous convection across central India is associated with strong winds across south India, including Chennai and Mumbai. “But in north India, the active period is marked by lower wind speed. So the wind-power potential is less during the active period,” Mr Kulkarni says.

When south India experiences less southwest winds during the break period, convective currents seen in north India bring in higher winds across northwest India. “This results in higher wind energy capacity across north India, including Delhi,” he says.

Though the wind speed is much higher in north India compared with south India during the break period, the wind energy cannot fully meet the energy demand in Delhi and Ahmedabad as the temperature is higher.

On the whole, the wind energy potential during summer monsoon (both active and break periods) makes wind energy potential unpredictable or uncertain.

“But there is no significant change in the future wind energy potential across the country when the wind energy from the Arabian Sea is taken into consideration,” he says.

“Since wind energy is high during the active period and low during the break period, a proper energy management policy is important. It would be prudent to rely more on wind energy during the active period and look for alternative energy sources during the break period. This way there can be maximum utilisation of green energy,” says Prof. Ghosh.

### **Biodiesel body calls for lower state taxes**

Industry is not moving forward due to the hurdle caused by skewed tax rates, it says

High state taxes on biodiesel are effectively rendering the green fuel significantly more expensive than regular diesel, according to the Biodiesel Association of India, which

also called on the central government to continue with the excise duty exemptions for the sector.

“The industry is just not moving ahead because of skewed rates of taxation, which continue to be a major hurdle,” Sandeep Chaturvedi, President of the Biodiesel Association of India (BDAI) told The Hindu.

“The taxes by the state government are very high. As soon as biodiesel is blended with diesel, the taxes can go as high as 20-30% depending on the state government. The biodiesel itself becomes Rs. 7-8 more expensive than diesel because of the tax element.”

### **Biodiesel consumption**

According to Mr. Chaturvedi, the annual consumption of biodiesel in India is about 80 lakh litres, which, he said, needed to go up drastically if India is to meet its target of a 10% reduction in oil imports.

In the July 2015 interim Railway Budget, the government had said that railways would blend up to 5% of biodiesel with their fuel.

“That immediately started activity across the country,” Mr. Chaturvedi said. “Out of the 16 zonal railways, 15 started using biodiesel. Now the key hurdle there was the marketing regulation.

“The law is from 2005 and it says that nobody other than the OMCs approved by the Ministry of Petroleum is allowed to sell. This was amended on January 16, 2015 by the Cabinet and biodiesel was allowed to be sold to private consumers. That was notified by the Ministry after about eight months.”

Regarding the high rates of state taxes, Mr. Chaturvedi said that the BDAI had approached the Centre but they could not alter state-level tax rates.

However, a few states, including Andhra Pradesh and West Bengal, have taken the initiative and have reduced the tax rates, he said.

“From April 1 till [the time] GST comes, the excise incentives for biodiesel should continue,” Mr. Chaturvedi said. “Otherwise the entire exercise would come to a standstill.”

### **Environmental costs**

“In India, if the environmental costs are not being borne by the government, then they are not quantified at all,” he added. “Now, finally, IIT Mumbai has done a study and they have come up with a startling finding that in 2015, about 82,100 died of air-related diseases, mostly due to vehicular pollution.”

“Using biodiesel can reduce hydrocarbon usage by almost 80%, and particulate matter emissions can be reduced by 38-40%, and there are no sulphur emissions,”





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Mr. Chaturvedi said.

He added that another study by the Meteorological Department had found that the rainwater has turned highly acidic in many areas.

"In some places like Nagpur, the pH level has risen to 4.5, which is highly acidic," he said.

"And then you talk about the farmer not getting his yields, and the poor fellow won't even know why even if it rains sufficiently," Mr. Chaturvedi said.

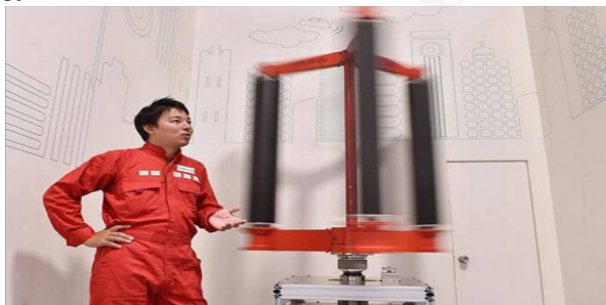
### Japan scientist's 'typhoon turbine'

Most people look for a place to hide when a typhoon is on the horizon, but Atsushi Shimizu hopes that the fury of nature may one day help resource-poor Japan tackle its energy woes.

As thousands of Australians seek shelter from a "monster" cyclone battering the country's northern coast, the Tokyo-based engineer believes that his bladeless wind turbine can not only stand up to the raw force of these destructive storms, but also harness that power to generate electricity.

Mr. Shimizu's egg-beater shaped creation — the device has three cylinders and a central rod — responds to wind coming from any direction and does not use a propeller to spin. Instead it takes advantage of the Magnus effect, a force that sees air curve when passing by a spinning object, such as a football.

"There are some estimates that wind power has more potential here than solar," said the 37-year-old, who quit his job at an engineering firm to launch start-up Challengery in 2014.



"But we haven't been able to turn that much of this wind power into actual energy here in Japan," he said.

Japan turned to expensive and polluting fossil-fuel options when it shut down dozens of nuclear reactors in the wake of the 2011 Fukushima accident.

### Public wary

A quake-sparked tsunami swamped the plant in Fukushima, sparking the worst atomic disaster since Chernobyl

in 1986.

Six years later, a wary public is resisting government efforts to switch reactors back on — boosting interest in solar, wind and other renewable energy sources.

The amount of electricity produced by wind nearly doubled in 2016 from a year earlier, according to a recent survey by the Japan Wind Power Association.

### Solar-powered water purifier developed

Researchers have developed a solar-powered purifier, which could provide a highly efficient and inexpensive way to turn contaminated water into potable water for personal use.

The device could help address global drinking water shortages, especially in developing areas and regions affected by natural disasters, researchers said.

"Using extremely low-cost materials, we have been able to create a system that makes near-maximum use of solar energy during evaporation. At the same time, we are minimising the amount of heat loss during this process," said lead researcher Qiaoqiang Gan, Associate Professor at the University at Buffalo in the U.S.

The team built a small-scale solar still. The device, called a "solar vapour generator," cleans or desalinates water by using the heat converted from sunlight.

### New light-absorbent material cools buildings

Scientists have developed a thin, flexible, lightweight material that can block thermal detection and absorb light from every angle to keep buildings and cars cool on hot summer days.

The material, developed by engineers at the University of California San Diego in the U.S., is called a near-perfect **broadband absorber**.

It absorbs more than 87 per cent of near-infrared light (1,200 to 2,200 nanometre wavelengths), with 98 per cent absorption at 1,550 nanometres, the wavelength for fiber optic communication.

The material is capable of absorbing light from every angle. It also can theoretically be customised to absorb certain wavelengths of light while letting others pass through. Materials that "perfectly" absorb light already exist, but they are bulky and can break when bent. They also cannot be controlled to absorb only a selected range of wavelengths, which is a disadvantage for certain applications. Imagine if a window coating used for cooling not only blocked infrared radiation, but also normal light and radio waves that transmit television and radio programmes.

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By developing a novel nanoparticle-based design, a team led by professors Zhaowei Liu and Donald Sirbuly at the UC San Diego has created a broadband absorber that is thin, flexible and tunable.

"This material offers broadband, yet selective absorption that could be tuned to distinct parts of the electromagnetic spectrum," said Liu.

The absorber relies on optical phenomena known as surface plasmon resonances, which are collective movements of free electrons that occur on the surface of metal nanoparticles upon interaction with certain wavelengths of light. Metal nanoparticles can carry a lot of free electrons, so they exhibit strong surface plasmon resonance — but mainly in visible light, not in the infrared.

The researchers reasoned that if they could change the number of free electron carriers, they could tune the material's surface plasmon resonance to different wavelengths of light.

"Make this number lower, and we can push the plasmon resonance to the infrared. Make the number higher, with more electrons, and we can push the plasmon resonance to the ultraviolet region," said Sirbuly.

The problem with this approach is that it is difficult to do in metals. To address this challenge, engineers designed and built an absorber from materials that could be modified, or doped, to carry a different amount of free electrons: semiconductors.

Researchers used a semiconductor called zinc oxide, which has a moderate number of free electrons, and combined it with its metallic version, aluminium-doped zinc oxide, which houses a high number of free electrons — not as much as an actual metal, but enough to give it plasmonic properties in the infrared.

The study was published in the journal Proceedings of the National Academy of Sciences. — PTI

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## ENVIRONMENT AND ECOLOGY

### Centre lifts 'green tape' threat on new mines

With more than 300 proposed mines facing the prospect of becoming non-starters due to their inability to secure environmental clearances before a January 11, 2017, deadline to register mining leases, the Centre has stepped in to give a fresh lease of life for such mines by allowing States to grant such leases irrespective of the status of the environmental clearance.

However, miners have been prohibited from initiating operations at such mines till the time they secure the requisite green clearances, as per an order notified by the Mines Ministry.

#### Letter of Intent

Since the Mines and Mineral (Development and Regulation) Act of 2015 requires all mining rights to be auctioned, all miners who had secured a Letter of Intent for operating a mine from a State government before January 12, 2015, were given a two-year window to execute and register their mining leases.

### New species of gibbon found in China

Scientists have discovered a new species of gibbon living in south-west China's rainforests.

Although scientists had been studying the primate for some time, new research has revealed that it is in fact a different species. It has been named the 'Skywalker hoolock gibbon' by its discoverers, who are Star Wars fans. The name is also a nod to the fact that the Chinese characters of its scientific name, Hoolock tianxing, and mean "Heaven's movement".

Dr. Sam Turvey, from the Zoological Society of London, who was part of the team studying the apes, told BBC News: "In this area, so many species have declined or gone extinct because of habitat loss, hunting and general human overpopulation.

"So it's an absolute privilege to see something as special and as rare as a gibbon in a canopy in a Chinese rainforest, and especially when it turns out that the gibbons are actually a new species previously unrecognised by science."

The research team, led by Fan Peng-Fei from the Sun Yat-sen University in China, first suspected that the gib-

bons that they were studying in Gaoligongshan nature reserve in Yunnan Province might be different because of subtle differences in the typical facial markings of white eyebrows and beards.

Gibbons are renowned for their loud song, which they use to mark territory, and this also sounded unusual.

#### 200 living in China

A full genetic and physical comparison with other gibbons then confirmed that they had found a new species. The scientists estimate that about 200 Skywalker gibbons are living in China and also potentially in neighbouring Myanmar, but say the species should already be classified as endangered. Habitat loss and fragmentation is putting the gibbons at risk of extinction.

In the Gaoligongshan nature reserve, where the gibbons were discovered, scientists had to trek up to 2,500 metres to find suitable habitat as "everywhere below there has been logged", Dr. Turvey told the BBC.

### Influence of orography on tropical rain physics

The size of rain drops influences natural events such as soil erosion and landslides. Larger drops could cause more soil erosion that may serve as triggering factors for landslides. The size of rain drops is influenced by the orography (topographic features of mountains) of places when the rain rate is high, says a study carried out by R. Harikumar, a scientist of the Indian National Centre for Ocean Information Services, Hyderabad. The size of rain drops has a significant effect on soil erosion and landslides. Larger drops could cause more soil erosion that may serve as triggering factors for landslides,

In a paper published in Atmospheric Science Letters, Dr. Harikumar found that rainfall in the Western Ghats region has larger drops compared with those in plain lands when the rain rate is high.

The study was carried out by comparing the rain drop size distribution characteristics at coastal and high altitude tropical stations. Rain data were collected from Kochi, Sriharikota, Munnar and Thiruvananthapuram.

Rainfall at Munnar consists of less number of bigger drops than in Kochi, Sriharikota, and even than Thiruvananthapuram. The rain in the Ghat region was dominated by bigger drops, which could account for more incidents of soil erosion, the paper concluded.

The drop size distribution characteristics at Munnar were very different from other stations. The only difference that Munnar possessed when compared to other stations was that, topographically, it was a hill-station situated on the





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Indian Western Ghats, it said.

The rain in Munnar was found to be made up of fewer but larger drops compared with any other stations in the plains, especially when it rained heavily. Even when it rained heavily in Kochi and SHAR, it is made up of more number of smaller drops compared to Thiruvananthapuram. Such a difference for Thiruvananthapuram also is attributed to the difference in orography at Thiruvananthapuram compared to Kochi and SHAR, the paper concluded.

The rain physics at Thiruvananthapuram and Munnar were comparable. Thiruvananthapuram has an orographic similarity with Munnar as it is closer to the foothills. Kochi is quite far from the foot hills of the Western Ghats, and hence, orographically, so different from Thiruvananthapuram.

### Environment Ministry postpones forest policy indefinitely

The Environment Ministry has indefinitely postponed an ambitious plan to update India's forest policy.

It has also decided to abstain from committing to a timeframe by which it would have a third of India's land under forest or tree cover, a key promise of the forest policy.

"...The Ministry of Environment, Forest and Climate Change (MoEFCC) has not set up any timeframe for formulation of the new forest policy and, as of now, the draft version of the policy is not ready," Anil Madhav Dave, Union Minister for Environment, Forests and Climate Change, said in a written reply to the Lok Sabha.

"The national goal is to have a minimum of one-third of the total land area of the country under forest or tree cover. However, no time limit has been prescribed to achieve this target," the Minister wrote.

The MoEFCC had tasked the Bhopal-based Indian Institute of Forest Management (IIFM), an affiliated organisation, with reviewing and revising the existing forest policy. This was the first time that the policy was being re-looked since 1988 as it wanted to update the several changes in the forest laws and provide a forward-looking policy that talked about increasing India's forest cover and tackling the effects of climate change.

The organisation had submitted its report and was available on the Environment Ministry's website, as a "Draft National Policy."

However, on June 22, the Ministry rejected the report and claimed it had "inadvertently" uploaded the draft policy and claimed it to be so, when it was only a "study" by the IIFM.

The draft policy, as The Hindu reported on June 22, made several suggestions including promoting the commercial use of wood, a greater role for industry in forest management and time-bound reviews of the progress being made in effectively managing forests. It, however, had not explicitly mentioned the role of tribals in forest management and the protections accorded by the Forest Rights Act.

### 'It is time to leave the history of coal behind'

Strict emission standards, an enabling regulatory framework, and a high price on carbon are some of the key ways India can boost its natural gas sector, according to the International Gas Union, a non-profit organisation comprising natural gas majors from around the world.

"There is a role for the government in enabling the right regulatory regime to allow the construction of the pipelines that transport gas from where it is produced to where the markets are," David Carroll, President of the International Gas Union (IGU) told The Hindu in an interview. "In addition, the regulation must also allow third-party access in the way one does with power lines or telecom lines to ensure that buyers, sellers and transporters can ensure that the product can move freely without undue barriers."

The more than 140 members of the IGU are associations and corporations of the gas industry representing more than 95 per cent of the global gas market, and they work together to help countries, such as India, move towards a higher share of natural gas in their energy mix.

"Another important area to work on is emission standards," Menelaos Ydreos, Executive Director of Public Affairs at IGU added during the interview. "Be stricter on those so you have to innovate to meet those standards. If coal can innovate to meet them, then more power to them. To the extent that gas can innovate, more power to gas."

"But that way you are not picking a winner or loser. You are letting the market respond to the requirements. However, the most efficient instrument is to put a price on carbon."

"Gas is 50 per cent cleaner than coal on carbon emissions, significantly cleaner on sulphur oxides and nitrogen oxides, and has virtually non-existent PM 2.5 emissions, which is the big issue with respect to air quality," Mr. Ydreos added. "And this holds whether you burn imported gas or domestically produced gas."

### Coal conundrum

India's reliance on coal as a source of energy is normal for a developing economy, Mr. Carroll said, but the need



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to balance economic growth with environmental concerns means that there are significant opportunities in the gas sector.

"Like much of the developing world, you have a reliance on coal," he said. "Even well-developed economies still have coal as a sizeable part of their portfolios, but it has diminished over time. These economies, it's all they did, burn coal and wood.

"It's an evolution, societies tend to decarbonise as they progress."

"But if you couple that challenge with tremendous economic growth, population growth, urbanisation... it creates challenges but also opportunities," he added. "And it certainly creates an environment where a 6.5 per cent to 15 per cent jump is not only achievable but also desirable due to the economic benefits that gas can provide and also the environmental benefits.

Mr. Carroll was referring to the Indian government's commitment to increase the share of gas in the energy mix from the current 6.5 per cent to 15 per cent. The global average share of gas in the energy mix is 24 per cent.

"Domestic production used to meet domestic demand," Mr. Ydreos explained. "While demand has steadily increased, domestic production of gas has declined. And that's why now India has become an importer of LNG. I think it was largely a mentality of 'we have a growing economy, we have domestic resources such as coal, and so we'll use those as we grow our economy'. The difficulty with that is to continue like that is counter to some of the climate change aspirations and environmental issues in India. It is a historical reason why coal has been preferred, but now it is time that history is left behind," he said.

However, despite gas' low share in India's energy mix compared with developed countries, this aspect is comparable with the energy situation in other developing countries, especially China.

"China is in the same range as India is right now, with a target to reach 10 per cent gas by 2020 and 12 per cent by 2030," Mr. Carroll said.

#### **Renewable push**

The Indian government has strongly committed to its targets of reducing emissions by 33 per cent by 2030, as set out during the COP21 summit in Paris, and towards this it has initiated a strong push towards a gas-based economy and has also invested heavily in renewable energy. The business opportunities this presents has not been lost on the international business community, according to Mr. Carroll. However, he also warned against

investing too heavily in renewable energy at a time when the technology is not yet ready.

"You have to bring renewables at the right time so you aren't trying to bring them to market before they are actually ready," Mr. Carroll said. "In which case, you are left with inefficient and costly subsidies for technologies that may be irrelevant in the near future."

"India has a tremendous potential for solar energy," he added. "We all realise that we have to stop burning dead dinosaurs to get our fuel. But certain renewables are still going through their cost curves and learning curves to get the required amount of output and to jump into it too big too soon leads to inefficient subsidies."

"There is tremendous interest in the opportunities for natural gas in India," Mr. Carroll said. "There are opportunities wherever we are seeing a growing population and the vast movement of people into urban environments, and raising standards of living, and the ensuing huge increase in energy consumption. But with that you need to keep in mind the environmental challenges, so natural gas is definitely one of the fuels there, and so are renewables."

However, despite the sector-specific regulatory hurdles the government can remove, the key to encouraging foreign investment is stability, according to Mr. Ydreos.

"Nothing encourages investment more than a regulatory environment that is predictable and is stable and ensures that there is an appropriate risk-reward for the investor," he said. "If you want to attract large investments into India, that's a precondition. That's what the investment community needs to see."

#### **Cost accounting**

Overall, while coal is cheaper than gas to produce, it works out to be significantly more expensive when externalities like health costs and environmental costs are worked into the equation.

"If you have two existing plants, a combined cycle gas plant and a coal plant, the coal plant on a marginal cost basis is cheaper," Mr. Ydreos said. "Once you include the externalities, though, such as healthcare costs and climate change impacts, then gas is the more affordable option. In new construction, gas fares better than coal. You can construct much faster, get approvals easier, and the initial capital is less than coal."

However, even if India ramps up its production of natural gas, it will still need to import gas for the foreseeable future, Mr. Carroll said, warning that this must not become an over-reliance on imports.

"You will need to import," Mr. Carroll said. "But I was lis-



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tening to Prime Minister Modi speaking at the Petrotech conference and he was talking about the strategies for energy.

He did talk about plans for enhanced development of India's gas resources, conventional, offshore, and potential for shale gas development. There was some early-stage development in shale gas that, if it took off, could be a rapidly developing source. "At the same time, there is development on your import capabilities both in terms of on-land terminals and floating terminals," he added.

"But clearly work needs to be done on the domestic production side to keep pace, so that you don't become overly reliant on imports."

Private investment in the domestic natural gas market is set to increase in the future due to the pegging of the price of natural gas to the international market, Mr. Ydros said.

"The biggest disincentive for domestic production was price," he said. "That was what kept it suppressed. Now that we have a new pricing scheme in India, you will see domestic production pick up."

### Urbanising India needs sustainable solutions: Otis

Otis India, the subsidiary of Otis Elevator Company, the world's leading manufacturer of elevators, escalators and walkways, has entered the high-volume elevators market for affordable housing by introducing energy-efficient elevators in the Indian market.

Called Gen2 Core, these elevators can attain a speed of 0.7 metres per second and provides options of machine room or machine-less room arrangements. They are designed for low-rise residential buildings with a height of seven floors.

Affordable homes make up almost 90 per cent of the demand for homes in India and this has become one of the focus areas for Otis, a top official said.

Otis already had been deploying Gen2 technology in elevators for high-rise buildings since 2010 and the Gen2 Core elevators are built on this technology platform.

This product is an upgrade from traditional rope-gearred systems to the permanent magnet (PM) gearless-belted technology ensuring energy-saving.

"The Gen2 Core uses Otis's patented, flexible polyurethane-coated steel belts, the ReGen regenerative drive, which captures energy that is normally wasted during braking and feeds it back into the building's electric grid, compact gearless machine and pulse monitoring system," said Sebi Joseph, President, Otis India.

The Gen2 Core, he said, offered the affordable housing segment an elevator that is 'environmentally responsible'. As India continued to urbanise, it needed sustainable solutions, he said, adding, "The Gen2 offers just that through its energy-saving and space conservation features."

The Gen2 Core will be manufactured in India at Otis' facility in Bengaluru with a delivery schedule of five weeks. Affordable Housing

The current housing deficit in India stands at 19 million units and 95 per cent of this deficit is around the Economically Weaker Sections and Low Income Group segments. This segment is likely to get a boost as the government is aiming to provide housing for all by 2022.

"Affordable homes do not just mean the cost accessibility of the home but also lower operational and maintenance costs. Sustainable features are key to any affordable housing project. This product will help us to penetrate across the country especially into tier-1 and -2 cities," Mr. Joseph said.

Gen2 Core would cost approximately 15 per cent more compared with products with similar speeds in the market.

India's new elevator market is estimated at 48,000 units per year and overall, the market is growing by 7 to 8 per cent.

However, Otis India, with a market share in the 'mid-teens,' has reported 20 per cent growth in its order book so far this year.

This year the firm bagged new orders from Mantri Developers and Indiabulls, out-bidding rivals. Otis will supply 1,000 elevators and escalators to Mantri Developers for its projects and 37 high-speed elevators, including 18 SkyRise elevators to the Indiabulls BLU Project in Mumbai.

### Why shouldn't diesel buses be barred from entering Delhi: NGT

Six neighbouring States of Delhi have been asked by the National Green Tribunal why they should not be directed to completely stop the operation of diesel buses coming to the national capital.

Noting that ambient air quality was poor during winters, a bench headed by NGT Chairperson Justice Swatanter Kumar asked the States of Rajasthan, Uttar Pradesh, Uttarakhand, Punjab, Himachal Pradesh and Haryana to take clear decision on switching to CNG vehicles and buy buses with additional fuel cylinders to resolve the issue of providing sufficient fuel in these buses. "It is contended

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before us that ambient air quality is much poorer compared to the prescribed standards and there is serious environmental and public health issues arising from the pollution. It is so more particularly in the areas of Anand Vihar, Patparganj and Sahibabad.

“Counsel appearing for the State of Uttarakhand, UP, Rajasthan, Haryana, Punjab and Himachal Pradesh to take clear instructions from their governments as to why they should not be directed to stop operating diesel buses destined to Delhi or passing via Delhi and instead operate CNG buses...,” the Bench said.

The NGT also directed Delhi Pollution Control Committee and UP Pollution Control Board to provide complete details in regard to the air pollution resulting from the industries in Patparganj, Sahibabad and Anand Vihar within a week.

It asked them to find out what pollutants are discharged by industrial units in these areas and steps that are required to be taken by them.

The matter was listed for next hearing on December 23. In October, the green panel had rapped the states for not being clear on their policy for CNG vehicles and warned of halting state transport if they did not introduce CNG, saying most particulate matters in the air inhaled by Delhiites emanated from there.

The Bench was hearing a plea filed by Kaushambi Apartments Residents Welfare Association (KARWA). In its petition, KARWA had highlighted how the presence of two bus terminuses within 200 metre of each other in Kaushambi has exacerbated air pollution in the area and sought to relocate the Kaushambi bus stand.

### Newly discovered snake has rainbow-hued head

A rainbow-headed snake, a tiny frog and a lizard with dragon-like horns are among more than 150 new species confirmed by scientists last year in the ecologically diverse but threatened Mekong region, researchers said. Winding its way from the Tibetan plateau through the mountains and jungles of Southeast Asia, the Mekong river helps sustain one of the most diverse regions on the planet. Each year scientists announce new species, after an often lengthy identification process, highlighting how much more there is to learn about the region. But there are fears many species may die out before even being discovered in an area of the world that is rapidly developing, where rule of law is notoriously shaky and wildlife smuggling rampant.

“The Greater Mekong region is a magnet for the world’s

conservation scientists because of the incredible diversity of species that continue to be discovered here,” Jimmy Borah, from WWF’s Greater Mekong team said.

The Greater Mekong region — which includes south-western China, Vietnam, Cambodia, Laos, Thailand and Myanmar — is under intense pressure from dam and road building as well as a thriving illegal wildlife trade.

“Many collectors are willing to pay thousands of dollars or more for the rarest, most unique and most endangered species,” Mr. Borah said. In total, scientists described 163 new species in 2015 including nine amphibians, three mammals, 11 fish, 14 reptiles and 126 plants.

Among the most eye-catching are Parafimbrios lao, a snake found in the limestone karsts of northern Laos whose scales reflect rainbow-like colours around its head. On the Thai tourist island of Phuket, which has seen huge development in recent decades, scientists found a lizard (Acanthosaura phuketensis) with a fearsome-looking ridge of horns down its head and back.

And in the country’s northern Chiang Rai province researchers found a newt (Tylototriton anguliceps) with dazzling red and black markings that they likened to a Klingon’s head from the Star Trek franchise.

In Cambodia and Vietnam, a new frog species that could fit on a finger tip was also discovered. At 3cm long, Lepidolalax isos, can fit on a finger tip.

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### Robot provides rare glimpse of world under Antarctic sea ice

An underwater robot has captured a rare glimpse beneath the Antarctic sea ice, revealing a colourful world filled with coconut-shaped sponges, dandelion-like worms, pink algae and spidery starfish.

The Australian Antarctic Division (AAD) took footage on a camera attached to a Remotely Operated Vehicle sent down by scientists through a small hole drilled in the ice as they recorded the acidity, oxygen, salinity and temperature of the seawater. "When you think of the Antarctic coastal marine environment, the iconic species such as penguins, seals and whales usually steal the show," AAD biologist Glenn Johnstone said.

"This footage reveals a habitat that is productive, colourful, dynamic and full of a wide variety of biodiversity, including sponges, sea spiders, urchins, sea cucumbers and sea stars."

These species, recorded near Australia's Casey research station, live in water that is -1.5 degrees Celsius year round and covered in 1.5 metres of sea ice for 10 months of the year.

"Occasionally an iceberg may move around and wipe out an unlucky community, but mostly the sea ice provides protection from the storms that rage above, making it a relatively stable environment in which biodiversity can flourish," he said.

#### **Ocean acidification**

Scientists in Antarctica are working on better understanding of the impact of acidification on Southern Ocean sea-

floor communities under increasing carbon dioxide emissions.

Project leader Johnny Stark said a quarter of the carbon dioxide emitted into the atmosphere was absorbed by the ocean, which increases its acidity.

"Carbon dioxide is more soluble in cold water and polar waters are acidifying at twice the rate of tropical or temperate regions. These ecosystems are expected to be among the first impacted from ocean acidification," he said.

"Research shows the pink encrusting algae, known as crustose coralline algae, may decrease in extent in a more acidic future ocean, as it incorporates calcium into its structure, and this becomes harder for organisms to obtain as the acidity of the seawater increases," he added.

### NGT bans open waste burning

The National Green Tribunal (NGT) imposed a complete ban on burning of waste in open places and announced a fine of Rs. 25,000 on each incident of bulk waste burning. "We direct that there shall be complete prohibition on open burning of waste on lands, including at landfill sites. "For each such incident, violators, including project proponent, concessionaire, any person or body responsible for such burning, shall be liable to pay environmental compensation of Rs. 5,000 in case of simple burning, while Rs. 25,000 in case of bulk waste burning," a Bench headed by NGT Chairperson Justice Swatanter Kumar said.

#### **Ban on PVC**

While directing every State and Union Territory to enforce and implement Solid Waste Management Rules, 2016, the green panel also asked the Environment Ministry and all States to pass appropriate directions in relation to the ban on short-life Polyvinyl Chloride (PVC) and chlorinated plastics within a period of six months.

"All State governments and Union Territories shall prepare an action plan in terms of the Rules of 2016 and the directions in this judgment within four weeks from the date of pronouncement. The action plan would relate to the management and disposal of waste in the entire State. The steps are required to be taken in a time-bound manner.

"Plans for processing and disposal of waste and selection and specifications of landfill sites which have to be constructed, be prepared and maintained strictly in accordance with the Rules of 2016," the NGT said.

#### **Waste segregation**

It further held that non-biodegradable waste and non-

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recyclable plastic should be segregated from the landfill sites and used for construction of roads and embankments in all road projects.

### Newly discovered fish named after Obama

After a trapdoor spider, a speckled freshwater darter (fish), a parasitic hairworm and an extinct lizard, outgoing U.S. President Barack Obama now has a new species bearing his name.

Scientists have named pink-and-yellow coral-reef fish — found exclusively within the protected area in Hawaii — in honour of Mr. Obama. The fish now bears the formal scientific name *Tosanoides obama*.

The fish was discovered during a June 2016 National Oceanic and Atmospheric Administration expedition to Papahānaumokuākea Marine National Monument in the Hawaiian Islands.

On August 26, at the urging of the Hawaii Democrat Senator Brian Schatz, and various conservationists and marine scientists, Mr. Obama had expanded the Papahānaumokuākea Marine National Monument. At 15,08,870 sq.km, it is the largest permanent marine protected area on Earth.

“We decided to name this fish after President Obama to recognise his efforts to protect and preserve the natural habitat, including its expansion,” said lead author Richard Pyle, Bishop Museum scientist.

#### Last great wilderness

“The expansion of Papahānaumokuākea adds a layer of protection to one of the last great wilderness areas on Earth,” Mr. Pyle added. Male *Tosanoides obama* have a distinctive spot on the dorsal fin near the tail, which is blue around the edge and red with yellow stripes in the centre.

“It is reminiscent of President Obama’s campaign logo so seemed especially appropriate for the fish to be named in honour of the President,” Mr. Pyle said. The species was first collected on a dive of 91 metres depth at Kure Atoll, 1,930 kilometres northwest of Honolulu.

It is special because it is the only known species of coral reef fish endemic to the Monument.

### Centre’s safety body warns against use of mobile wallets, PoS devices at fuel stations

The Petroleum and Explosives Safety Organisation (PESO) has urged the Centre to warn retailers against using mobile wallets and point of sale devices at petrol

pumps.

“We have told the petroleum ministry that the use of mobile wallets and swipe machines for debit cards should be avoided while a vehicle is being fuelled and a hazardous area around the fuel dispensing area must be clearly and prominently marked out,” a senior industry ministry official told The Hindu.

#### Explosives Act

The PESO, entrusted with the administration of the Explosives Act of 1884 and the Petroleum Act of 1934, reports to the Department of Industrial Policy and Promotion in the Ministry of Commerce and Industry. The official said it was now the petroleum ministry’s role to communicate these safety instructions to retail outlets for petroleum products.

“There would be no objection for the use of point of sale unit/mobile e-wallet beyond the hazardous area around the petroleum dispenser in petroleum retail outlets licensed under the Petroleum Rules, 2002,” Joint Chief Controller of Explosives N.T. Shahu wrote in a missive to the oil and industry ministries on December 19.

#### Hazardous zones

As per the norms regarding electrical appliances’ use around fuel pumps, there are two hazardous zones. Zone 1, which is most hazardous covers the area 1.2 metres vertically above the base of the fuel pump and 45 centimetres away horizontally in all directions. Zone 2 includes the area between 45 cms and six metres of the cabinet enclosing the fuel pump, extending 45 cms vertically above the floor level.

#### Public safety

National Disaster Management Authority’s previous vice-chairman M. Shashidhar Reddy wrote to Cabinet Secretary P.K. Sinha and called for urgent steps to ensure that these conditions laid out by the Petroleum and Explosives Safety Organisation are meticulously followed to prevent any untoward incidents.

“I request you to immediately direct the Petroleum & Natural Gas ministry and chief secretaries of all States to take necessary steps to comply with the advisory from PESO in a time bound manner,” Mr. Reddy said.

“This is extremely important from the point of view of public safety consequent to their being pushed to the use of digital payment platforms post demonetisation.”

### Kerala’s avian diversity gets richer

The avian species diversity of Kerala got a boost in the last days of 2016 with BirdLife International dividing a species in two. BirdLife International, an organisation





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which assesses the conservation status of birds globally, has split the group of montane laughingthrushes, which are endemic to the Western Ghats, and recognised them as two new species. As a result, Kerala now has four mountain laughingthrushes in place of two.

The newly accepted species are Banasura laughingthrush (*Trochalopteron jerdoni*), which has a very restricted distribution in Wayanad district and Travancore laughingthrush (*Trochalopteron merdionale*) found in Thiruvananthapuram district. While the conservation status of the Banasura species was assessed as endangered, the Travancore variety was considered vulnerable, considering the risk the species were facing.

The two original species of the family were Nilgiri laughingthrush and Palani laughingthrush. The Nilgiri species, assessed as an endangered one, is found in Silent Valley National Park and Siruvani hills of Kerala. The near-threatened Palani laughingthrush is found mainly in Munnar hills and the mountains of Periyar Tiger Reserve apart from Grass Hills and Palani hills in Tamil Nadu, according to ornithologists.

Dr. P.O. Nameer, Head, Wildlife Division of the Kerala Agriculture University, and J. Praveen, the coordinator of Bird Count India, which organises the national bird counting exercise, had been arguing for treating the Banasura and Travancore species as separate ones, considering how different they were from the other two. They had published a paper in 2012 making a strong case for splitting the species.

According to Dr. Nameer, colonial ornithologists had suggested way back in 1800s that all four laughingthrushes be treated as independent species. However, in the early 1900s, the concept of sub-species gained currency and two of them were wrongly treated as sub-species. It was in 2012 that a scientific assessment was carried out to establish the existence of four different species, he explained.

The identification of the two new species was carried out by following the internationally accepted scoring system. The morphological differences, the distribution of each species, its habitat and altitude preferences were identified through field trips. The scores obtained were sufficient to separately classify the species. The conservation status of the birds was also revisited after their reclassification, he said. BirdLife International recognised the findings and reclassified the birds in the latest Red List. Research papers on the genetic characteristics of each species are expected shortly, he said. Laughingthrushes are found only in the peaks of Western

Ghats, popularly known as sky islands. These mountain peaks are separated from the others so well that the birds from one sky island find difficult to move to the next sky island. This has resulted in the creation of four closely related species, each of them occupying a series of mountain tops across the entire range of southern Western Ghats, noted the ornithologists in a scientific paper.

### **New bird species found in Nepal**

Nepal has recorded a new species of bird from upper Dolpa, the largest district of the mid-western development region.

Discovery of a single individual of Rufous-tailed Rock Thrush (*Monticola saxatilis*) was made public at a press recently, Xinhua news agency reported. Rock thrushes are medium-sized songbirds, mostly insectivorous or omnivorous and fall under the genus of chats. The bird was photographed in May near the Shey monastery within the Shey-Phoksundo National Park of Dolpa. It is considered an autumn passage migrant in Pakistan and India.

A four-member team including young wildlife researcher of Nepal Naresh Kusi and Geraldine Werhahn from University of Oxford made the record during their visit to the region.

The team was studying the wild yak and snow leopard while they discovered this new bird species. Bird experts have claimed that more researches are needed to ascertain the status of Rufous-tailed Rock Thrush in other parts of Nepal. With this record, Nepal now has a total of 886 species of birds.

### **NIO begins fingerprinting tar balls to track oil spills**

Environmental forensic analysts are chasing tar balls in sea coasts to trace the source of marine oil spills.

The slicky job of forensic experts working in the environment sector came to focus last month following the leakage of huge quantities of crude oil into the sea off Ennore coast near Chennai.

Samples collected from the Ennore spill will be fingerprinted at the National Institute of Oceanography (NIO), Goa, shortly.

Tracking the source of oil pollution through fingerprinting is significant as it could identify the polluters and thus fix responsibility.

It will help in evaluating the spills and devising methods for averting them.

#### **Source determination**

Crude oil explored from each well has specific characteristics. A comparison of the characteristics of oil spills



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or tar balls with the crude oil will reveal the location from which the oil originated. After identifying the characteristics of the oil spill or tar balls, it would be easy to track them back to the source, said a communication from NIO. The facility at NIO, which was set up recently with the support of the DST, has been extensively used to analyse the source of tar balls deposited on the west coast of India, said S. Prasanna Kumar, Director, NIO.

The samples collected from the coast or water is subject to a series of chemical analyses to determine its characteristics for comparison with crude. The analysis can generate huge data bank on fingerprint results, which ultimately will be useful towards mitigation of oil pollution. The Institute has been collecting and fingerprinting the tar ball samples from the west coast since 2010. Besides the scientific identification of the source of oil pollution, the fingerprinting would reveal the residence time of the oil residues/tar balls in water and the deposit of the balls on the coast. The NIO has so far analysed the tar balls collected from Gujarat, Mumbai and Goa. Researchers plan to cover Karwar and Mangaluru coasts.

### Black rhinos on the brink of extinction

As the value of rhinoceros horn touches \$65,000 per kg, poaching has begun to drive the African black rhinoceros to "the verge of extinction" - not just by reducing its population size, but by erasing 70% of the species' genetic diversity - says a research paper published recently in Scientific Reports.

Genetic variation is the cornerstone of evolution, without which there can be no natural selection, and so a low genetic diversity decreases the ability of a species to survive and reproduce, explains lead author Yoshan Moodley, Professor at the Department of Zoology, University of Venda in South Africa.

Two centuries ago, the black rhinoceros - which roamed much of sub Saharan Africa - had 64 different genetic lineages; but today only 20 of these lineages remain, says the paper. The species is now restricted to five countries, South Africa, Namibia, Kenya, Zimbabwe and Tanzania. Genetically unique populations that once existed in Nigeria, Cameroon, Chad, Eritrea, Ethiopia, Somalia, Mozambique, Malawi and Angola have disappeared.

The origins of the 'genetic erosion' coincided with colonial rule in Africa and the popularity of big game hunting. From the second half of the 20th century, however, poaching for horns has dramatically depleted their population and genetic diversity, especially in Kenya and Tanzania.

### Museum collection

For the study, scientists used genetic data obtained from existing animals and museum samples (rhinoceros parts preserved in museum collections).

The paper calls for "a complete re-evaluation of current conservation management paradigms" for the black rhinoceros. "By identifying the genetic units remaining for surviving rhinos, we are effectively defining the boundaries within which management (be it translocations to increase genetic diversity or consolidation of populations for more effective protection) can be carried out without negatively affecting the gene pool," co-author Michael W. Bruford, Professor at Cardiff School of Biosciences, Cardiff University, U.K told The Hindu.

Greater the genetic diversity, the better is the population's ability to respond to pressures such as climate change and diseases, said Prof. Bruford. "Thus the loss of so much evolutionary potential in the black rhino is worrying for its future adaptability."

### What do the Quebec fossils prove?

Scientists believe they have found fossils dating back to at least 3.8 billion years, which might even help us find life on other planets. A team of scientists say they have discovered the oldest fossils on Earth in rocks from Quebec. Dating techniques suggest the rocks are at least 3.8 billion years old, and might even be 4.3 billion years old.

The fossils are tiny. They consist of filaments and tubes up to half a millimetre in length and around half the width of a human hair. They're made of haematite, a type of iron oxide (better known as rust). Some of the filaments resemble loose coils, some are branched, and others appear to be joined to knobs of haematite. They are thought to be the remains of bacteria that lived on iron and dwelt around hydrothermal vent systems - mineral-rich hot springs - on the seafloor. Similar systems have been proposed as a likely location for where life first arose.

How do we know these tubes and filaments are fossils? The authors of the study argue that the haematite structures are similar to those produced by iron-oxidising bacteria today, as well as to microfossils found in younger rocks, hundreds of millions - rather than billions - of years old. What's more, the structures were found to contain graphite as well as the minerals apatite and carbonate - which are associated with biological matter. Finally, the team found iron-oxide granules and, in other sections of the rocks, structures such as carbonate rosettes (also associated with apatite, graphite and carbonate), which, they say, could have formed as biological matter broke down. While the researchers say their investiga-



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tion ruled out the chance that the structures were formed by geological processes, others are not convinced. The rocks in which the fossils were found are metamorphic, meaning that they have experienced high temperatures and pressures since they formed — some argue that this could have produced the structures instead.

The size and arrangement of the haematite structures has also raised concerns, as has the fact that the microbes would have been breathing oxygen at a time when oxygen is thought to have been scarce. It raises the possibility that microbes were also thriving on Mars.

### **A brewing debate on evolution theory picks up in India**

The phenomenon of niche construction in evolutionary biology has been mooted to be highly important but neglected in evolutionary biology theory. Not just that, it has been termed a concept at par with natural selection. Five Indian evolutionary biologists connected to Evolutionary & Organismal Biology Unit of JNCASR, Bengaluru, have set out to show that this is not so. Apart from citing instances of the concept's use in earlier papers, they also argue that incorporating the phenomenon does not involve a major reworking of Standard Evolutionary Theory (SET). Their paper is soon to be published in the Journal of Genetics.

Over the last two decades, niche construction — the phenomenon by which evolving organisms modify their environment, which in turn increases or decreases their own survival rate — has become much talked about in the literature. Proponents of this theory have argued that it has been neglected in the Standard Evolutionary Theory, which therefore needs a major overhauling. This has been debunked in the paper by the authors. When posted on the Biorxiv, the paper got an unprecedented level of attention.

#### **A new domain**

It is interesting that evolutionary biologists from India are engaging in this debate on the concepts of evolutionary theory. Amitabh Joshi, one of the five authors of the paper, remarks, "We biologists from India have largely added to the compendium of facts, sometimes (mostly Indian ecologists and evolutionary biologists) to theoretical concepts, but hardly ever to fundamental debates about the conceptual foundations of the subject. For example, the foundational debates within evolutionary biology for the past 15 years have been dominated by scientists from North America and Western Europe."

One of the contentions of the authors is that contrary to

the claims that Niche Construction has been neglected in the Standard Evolutionary Theory, they show in the paper that it has been considered by many authors to explain phenomena, even before the term "niche construction" was coined. One of the examples they give is of an experimental study done by Borash and others in 1998: The experiment involved breeding larvae of fruit fly, *Drosophila melanogaster*, in an environment where food was reduced and presence of nitrogenous waste was increased. It was observed that even within one generation the larvae that formed early became heavy feeders and the late developers grew to become waste tolerant. Thus, within one generation, they were able to observe the effect of environment that was altered by the organism (the heavy feeders depleting the environment of food for the late developers). They found that it introduced the above polymorphism — separation into heavy feeders and waste tolerant types.

Proponents of niche construction use the following examples often: The use of lactose to feed adult humans — which is believed to have evolved along with cattle husbandry — and the high incidence of sickle cell anaemia in populations where there is a prevalence of malaria, due to yam cultivation. The authors debunk the claims by citing references of the above examples already having been used within the classical theory itself.

#### **Other claims**

They also deny some of the oft-quoted claims about it: for instance, that NC is more than an alternative perspective, and it is a serious body of formal evolutionary theory or that NC is an evolutionary process, at par with natural selection.

The article has drawn the attention of the international community as well. Prof. Jerry Coyne, eminent biologist and recipient of the Richard Dawkins award has written a blog post in which he agrees with most of the points made in the paper.

### **Oldest fossils hold clue to origin of life**

Life on Earth may have originated earlier than thought and could have done so in hydrothermal vents on the ocean floor. A new study in Nature finds the origin of life at at least 3,770 million and possibly 4,290 million years ago in ferruginous sedimentary rocks, interpreted as seafloor-hydrothermal vent-related precipitates from the Nuvvuagittuq supracrustal belt of Eastern Canada. Scientists led by Dr. Dominic Papineau of University College London made the discovery.

Epifluorescence imaging of modern vent samples has





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shown that cylindrical casts composed of iron oxyhydroxide are formed by bacterial cells and are undeniably of biological origin (biogenic). Hence, morphologically similar tubes and filaments in ancient jaspers may be taken as evidence that the jaspers held organisms that can survive elevated temperatures.

“The fact that we found microfossils in these rocks shows that within only a few hundred million years of the accretion of the Earth, life had not only originated, but had also already diversified into specialised microorganisms living in hydrothermal vent environments where biologists have been suggesting for years that that was the site for the origin of life on Earth,” noted Dr. Papineau in an email to this Correspondent.

The scientists found that NSB rocks contain graphite with ratios of the  $^{13}\text{C}/^{12}\text{C}$  isotopes (the two naturally occurring stable isotopes of carbon –  $^{13}\text{C}$  having one more neutron than  $^{12}\text{C}$ ) indicative of biological metabolism. The mineral graphite is composed of carbon and can form during the metamorphism of biological organic matter. It is the same for carbonate, but these minerals represent oxidised organic matter.

#### **Rosette remnants**

Microscopic spheroidally-concentric mineral structures called rosettes were found in the NSB rocks and are composed of apatite (the phosphate mineral in our teeth and bones), carbonate, and graphite. Also found were granules which are similar to rosettes, but slightly larger, up to 2 mm in diameter. The granules contain different iron minerals that indicate the former presence of chemical reactions. The scientists believe that both rosettes and granules are the mineralised products of putrefaction.

On the basis of chemical and morphological lines of evidence, the tubes, filaments and granules are best explained as remains of iron-metabolising (consuming iron) filamentous bacteria, and therefore represent the oldest life forms recognized on Earth.

“Some bacteria can literally eat iron, which is what we think these ones were doing more than 3.77 billion years ago. All these lines of evidence have also been documented in younger jasper that formed when we know life existed, as well as in modern ferruginous-siliceous (iron-silica containing) precipitates in the vicinity of hydrothermal vents. Hence, we conclude that we have found the oldest fossils known,” Dr. Papineau says.

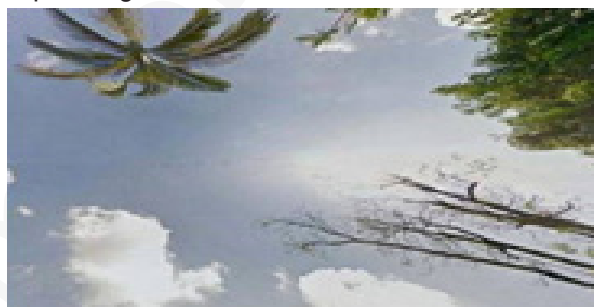
#### **Google Street View helps manage urban ecosystem**

Scientists have used over 100,000 images extracted

from Google Street View to map and quantify how street trees regulate urban ecosystems in megacities like Delhi and Shanghai.

While it was generally accepted that trees and plants helped in regulating urban ecosystems, until now researchers had very little data to quantify its extent.

Most of the research has been conducted in the temperate zones of Europe and North America, but little is known about how trees contribute to urban ecosystems in tropical regions.



Researchers in the Future Cities Laboratory at the Singapore-ETH Centre, a research outpost of ETH Zurich, developed a method to map and quantify how street trees regulate ecosystem services. Scientists analysed hemispherical photographs using an algorithm to quantify the proportion of green canopy coverage at 50 metre intervals across more than 80% of Singapore’s road network.

#### **High spatial resolution**

Google Street View’s technology allowed researchers to tap into a standard dataset of panoramic photographs and streetscapes that use a global positioning system (GPS) to map images to specific locations.

The high spatial resolution of the images allowed researchers to estimate the amount of solar radiation that reaches the Earth’s surface.

“In addition to cooling urban micro climates, these trees, which are integrated within dense urban street networks, also reduce the risk of flash flooding and helps in cleaning the air,” said Peter Edwards, Principal Investigator at the Future Cities Laboratory.

Researchers said that increasing the cover of the street tree canopy could reduce ground surface and air temperatures on Singapore’s streets.

“Providing trees to help cool the environment is important in tropical cities like Singapore, which suffers heavily from the urban heat island effect,” said Dan Richards, from the Future Cities Laboratory.

This new and relatively inexpensive method of rapidly estimating the amount of shade provided by street trees



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could help urban planners to identify areas of a city with low shade and prioritise the planting of new trees, researchers said

### Frog species named after Attenborough

A new frog species, which measures just about two centimetres and was discovered in the Peruvian Andes, has been named after noted British broadcaster and naturalist Sir David Attenborough.

While there are already a number of species, including mammals, reptiles, invertebrates and plants, both extinct and extant, named after the host of the BBC Natural History's Life series, not until now has he been honoured with an amphibian namesake.

The frog is formally described as *Pristimantis attenboroughi*, while it is to be referred to as Attenborough's rubber frog.

Living in Peru

Scientists from Illinois Wesleyan University and University of Michigan in the U.S., spent two years surveying montane forests in central Peru, in order to document the local amphibians and reptiles and evaluate their conservation statuses.

Their efforts were rewarded with the discovery of several new species of frogs and a lizard species.

Each of these discoveries, including the Attenborough's rubber frog, prove how beneficial it is to take into account both morphological and the genetic data, while looking for species new to science.

The Attenborough's rubber frog is known to inhabit several localities across the Pui Pui Protected Forest, a nature reserve located at elevations between 3,400 and 3,936 metres above sea level in central Peru. The adult males reach size of 14.6-19.2 millimetres in length, while the females are larger measuring between 19.2 and 23 mm. Their colour ranges from pale to dark grey or reddish brown to brownish olive with dark grey scattered flecks. The study was published in the journal *ZooKeys*.

### A mass coral bleaching again

Great Barrier Reef threatened by heat wave for second consecutive year

Australia's Great Barrier Reef is experiencing an unprecedented second straight year of mass coral bleaching, scientists said Friday, warning many species would struggle to fully recover.

The 2,300-km reef suffered its most severe bleaching on record last year due to warming sea temperatures during March and April.

Bleaching is once again occurring, the government's Great Barrier Reef Marine Park Authority said after an aerial survey off Australia's eastern coast.

"Regrettably, the temperatures have been high on the Great Barrier Reef this summer as well and unfortunately (we) are here to confirm... a mass coral bleaching event for the second consecutive year," the Authority's reef recovery director David Wachenfeld said.

"And importantly, this is the first time we've ever seen the Great Barrier Reef bleached two years in sequence. We've seen heat stress build since December."

The agency said more bleaching was being observed in the central part of the reef, which last year escaped widespread severe bleaching. The 2016 bleaching was more severe in the northern areas of the bio-diverse site.

The back-to-back occurrence of widespread bleaching also meant there was insufficient time for corals to fully recover, Neal Cantin from the Australian Institute of Marine Science said. "We are seeing a decrease in the stress tolerance of these corals," Mr. Cantin added.

"This is the first time the Barrier Reef has not had a few years between bleaching events to recover.



### Algae expelled

Bleaching occurs when abnormal environmental conditions, such as warmer sea temperatures, cause corals to expel tiny photosynthetic algae, draining them of their colour.

Corals can recover if the water temperature drops and the algae are able to recolonise them.

But researchers said in January coral reefs which survive rapid bleaching fuelled by global warming would remain deeply damaged with little prospect of full recovery. The Barrier Reef — already under pressure from farming run-off, development and the crown-of-thorns starfish — escaped with minor damage after two other bleaching events in 1998 and 2002.

Conservation group WWF-Australia said, the latest bleaching increased the urgency of tackling climate

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change in Australia, one of the world's worst per capita greenhouse gas polluters.

"I did not anticipate back-to-back bleaching this decade," WWF-Australia's oceans division head Richard Leck said. "Scientists warned that without sufficient emissions reductions we could expect annual mass bleaching of the Great Barrier Reef by 2050. Consecutive bleaching events have arrived 30 years early."

The reef scientists plan to conduct further surveys over the next few weeks to determine the extent and severity of the bleaching.

Nearly two-thirds of shallow-water corals in a 700-km stretch of the reef's northern section were lost to last year's bleaching event, scientists have said.

### **New clone of MRSA identified in Kerala aquatic environment**

If the concentration of the bacterium increases, it can reach the seafood chain

A new clone of methicillin-resistant *Staphylococcus aureus* (MRSA), which is exclusive to Kochi, has been identified. The new clone, christened 't15669 MRSA', is unique to seafood and the aquatic environment of Kerala. Scientists at the Central Institute of Fisheries Technology (CIFT), Kochi, identified the new clone while assessing the prevalence of MRSA in seafood and the environment. The study team comprised V. Murugadas, Toms C. Joseph, K.V. Lalitha and M. M. Prasad, all researchers at the Institute.

MRSA can lead to diseases ranging from milder form of skin infections, boils, furunculosis to life-threatening septicemia and bacteraemia from post-surgical contamination. The situation turns worse given their resistance to wide range of drugs, warned the researchers. However, as *S. aureus* causes disease by producing enterotoxin in the food, there is no immediate threat in consumption of seafood contaminated with MRSA.

"[The emergence of MRSA] has been identified as a health concern globally since the 1960s. However, little information is available on the prevalence of MRSA and its clonal characteristics in seafood and the aquatic environment," the researchers say in a paper published in the *Journal of Food Protection*.

According to Dr. Murugadas, if the new clone, which is currently low in concentration in the Kochi geographical area, gets established and becomes widely prevalent then it can reach the seafood chain starting from the fish landing centres to the retail outlets very frequently.

The presence of MRSA in fish meant for human con-

sumption is a potential health hazard for food handlers. The fingerprinting of MRSA can be useful for tracing local source and spread of MRSA isolates in a defined geographical area, they said.

#### **Accidental discovery**

According to C.N. Ravishankar, director of the CIFT, the scientists stumbled upon the new clone during a regular screening of fish samples, which the institute has been undertaking as part of its research and social responsibility activities. Fish samples collected from the landing centres as well as the markets are regularly screened at the CIFT labs to identify potential health hazards. Extensive research is being undertaken on MRSA.

India hosts world's oldest algae fossil

New find in the Chitrakoot region of U.P. and M.P. may rewrite evolution timeline

Scientists in India have uncovered a pair of 1.6 billion-year-old fossils that appear to contain red algae, which may be the oldest plant-like life discovered on Earth.

Until now, the oldest known red algae was 1.2 billion years old, said the paper in the journal *PLOS Biology*.

Scientists often debate the question of when complex life began on Earth, but they generally agree that large multicellular organisms became common about 600 million years ago.

This discovery could lead experts to rewrite the tree of life, said lead author Stefan Bengtson, Professor Emeritus of palaeo-zoology at the Swedish Museum of Natural History.

#### **No DNA remains**

"The 'time of visible life' seems to have begun much earlier than we thought," he said. No DNA remains in the fossils to be analysed but the material structurally resembles red algae, embedded in fossil mats of cyanobacteria inside a 1.6 billion-year-old phosphorite, a kind of sedimentary rock.

"You cannot be a hundred percent sure about material this ancient, as there is no DNA remaining, but the characters agree quite well with the morphology and structure of red algae," said Professor Bengtson.

Advanced tools — such as synchrotron-based X-ray tomographic microscopy — allowed scientists to observe regularly recurring platelets in each cell, which they believe are parts of chloroplasts, the organelles within plant cells where photosynthesis takes place.

Distinct structures at the centre of each cell wall are also apparent, and are typical of red algae.

The fossils were discovered in sedimentary rocks in the Chitrakoot region of Uttar Pradesh and Madhya Pradesh.





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The earliest traces of life on Earth — in the form of single-celled organisms — go back some 3.5 billion years.

### Oldest fossils hold clue to origin of life

Life on Earth may have originated earlier than thought and could have done so in hydrothermal vents on the ocean floor. A new study in *Nature* finds the origin of life at at least 3,770 million and possibly 4,290 million years ago in ferruginous sedimentary rocks, interpreted as seafloor-hydrothermal vent-related precipitates from the Nuvvuagittuq supracrustal belt of Eastern Canada. Scientists led by Dr. Dominic Papineau of University College London made the discovery.

Epifluorescence imaging of modern vent samples has shown that cylindrical casts composed of iron oxyhydroxide are formed by bacterial cells and are undeniably of biological origin (biogenic). Hence, morphologically similar tubes and filaments in ancient jaspers may be taken as evidence that the jaspers held organisms that can survive elevated temperatures.

“The fact that we found microfossils in these rocks shows that within only a few hundred million years of the accretion of the Earth, life had not only originated, but had also already diversified into specialised microorganisms living in hydrothermal vent environments where biologists have been suggesting for years that that was the site for the origin of life on Earth,” noted Dr. Papineau in an email to this Correspondent.

The scientists found that NSB rocks contain graphite with ratios of the  $^{13}\text{C}/^{12}\text{C}$  isotopes (the two naturally occurring stable isotopes of carbon –  $^{13}\text{C}$  having one more neutron than  $^{12}\text{C}$ ) indicative of biological metabolism. The mineral graphite is composed of carbon and can form during the metamorphism of biological organic matter. It is the same for carbonate, but these minerals represent oxidised organic matter.

#### Rosette remnants

Microscopic spheroidally-concentric mineral structures called rosettes were found in the NSB rocks and are composed of apatite (the phosphate mineral in our teeth and bones), carbonate, and graphite. Also found were granules which are similar to rosettes, but slightly larger, up to 2 mm in diameter. The granules contain different iron minerals that indicate the former presence of chemical reactions. The scientists believe that both rosettes and granules are the mineralised products of putrefaction.

On the basis of chemical and morphological lines of evidence, the tubes, filaments and granules are best explained as remains of iron-metabolising (consuming iron)

filamentous bacteria, and therefore represent the oldest life forms recognized on Earth.

“Some bacteria can literally eat iron, which is what we think these ones were doing more than 3.77 billion years ago. All these lines of evidence have also been documented in younger jasper that formed when we know life existed, as well as in modern ferruginous-siliceous (iron-silica containing) precipitates in the vicinity of hydrothermal vents. Hence, we conclude that we have found the oldest fossils known,” Dr. Papineau says.

### ‘Lost continent’ lies under Indian Ocean

Scientists have confirmed the existence of a “lost continent” under the Indian Ocean island of Mauritius that was left over by the break-up of the super-continent, Gondwana, which started about 200 million years ago.

The piece of crust, which was subsequently covered by young lava during volcanic eruptions on the island, seems to be a tiny part of ancient land that broke off from the island of Madagascar, when Africa, India, Australia and Antarctica split.

“We are studying the break-up process of the continents, in order to understand the geological history of the planet,” said Professor Lewis Ashwal from the University of the Witwatersrand in South Africa. By studying zircon, found in rocks spewed up by lava during volcanic eruptions, Mr. Ashwal and his colleagues have found that remnants of this mineral were far too old to belong to Mauritius.

“Earth is made up of two parts — continents, which are old, and oceans, which are “young”. On the continents, you find rocks that are over four billion years old, but you find nothing like that in the oceans, as this is where new rocks are formed,” said Mr. Ashwal.

“Mauritius is an island, and there is no rock older than nine million years old on the island. However, by studying the rocks on the island, we have found zircons that are as old as three billion years,” he said.

#### Rich record

Zircons are minerals that occur mainly in granite from the continents. They contain trace amounts of uranium, thorium and lead, and due to the fact that they survive geological processes very well, they contain a rich record and can be dated extremely accurately. “The fact that we have found zircons of this age proves that there are much older crustal materials under Mauritius that could only have originated from a continent,” said Mr. Ashwal.

This is not the first time that zircons that are billions of years old have been found on the island. A study done in



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2013 has found traces of the mineral in beach sand.

#### **Some concerns**

However, this study received some criticism, including that the mineral could have been either blown in by the wind, or carried in on vehicle tyres or scientists' shoes.

"The fact that we found the ancient zircons in rock (six million-year-old trachyte), corroborates the previous study and refutes any suggestion of wind-blown, wave-transported or pumice-rafted zircons for explaining the earlier results," said Mr. Ashwal.

He suggests that there are many pieces of various sizes of "undiscovered continent", collectively called "Mauritia", spread over the Indian Ocean.

"According to the new results, this break-up did not involve a simple splitting of the ancient super-continent of Gondwana, but rather, a complex splintering took place with fragments of continental crust of variable sizes left adrift within the evolving Indian Ocean basin," Mr. Ashwal said.

The results were published in the journal Nature Communications.

### **Mammals shrink in size when Earth heats up, study shows**

An artist's conception shows a comparison of a *Sifrhippus sandrae* (right) with a modern Morgan horse that stands about five feet tall. Florida Museum of Natural History/AP  
Warm-blooded animals would need to shed heat and so turn smaller

Global warming shrank certain animals in the ancient past, and scientists worry it could happen again. Warm-blooded animals got smaller at least twice in Earth's history when carbon dioxide levels soared and temperatures spiked as part of a natural warming, a new study says.

University of New Hampshire researcher Abigail D'Ambrosia warned that mammals but not people could shrivel in the future under even faster man-made warming.

"It's something we need to keep an eye out for," said Ms. D'Ambrosia, who led the new work. "The question is how fast we are going to see these changes."

#### **Dwarfing phenomenon**

Three different species shrank noticeably about 54 million years ago when the planet suddenly heated up.

One of them an early, compact horse got 14% smaller, going from about 17 pounds (7.7 kilograms) to 14.6 pounds (6.6 kilograms), according to an analysis of fossil teeth in Wednesday's journal *Science Advances*.

"These guys were probably about the size of maybe a

dog, then they dwarfed," said Ms. D'Ambrosia. "They may have gone down to the size of a cat."

Another creature that contracted was a lemur-like animal that's the earliest known primate.

It shrank about 4%; while it may not seem like much, it's noticeable because studies of the animal over millions of years showed it was usually getting bigger over time, Ms. D'Ambrosia said.

#### **Equine ancestor**

Previous studies have documented a similar shrinking of mammals, including another early horse ancestor, during an earlier warming about 56 million years ago. Scientists and farmers have also long tracked animals, such as cows, that shrink and give less milk during hotter stretches.

This latest work shows heating and shrinking are connected over millions of years.

"These results are very significant because they provide another independent test of whether climate drives changes in body size in mammals," said Jonathan Bloch, curator of vertebrate palaeontology at the Florida Museum of Natural History, who wasn't part of the study.

"If we start to see patterns repeat themselves, we can learn from that. And what we learn from these lessons will certainly be important as we think about the possible response of plants and animals to future climate change."

#### **Shedding skin or fur**

Both Ms. D'Ambrosia's study and that of the earlier warming are based on fossils recovered from the Bighorn Basin of Wyoming. Ms. D'Ambrosia said it's unlikely that the shrinking only happened there.

In hotter climates, mammals and other warm-blooded animals need to shed heat so they shrink. Smaller animals have more skin or fur per pound than bigger animals so more heat can escape, making them better adapted for warmer climate.

Larger animals do better in the cold because they have less skin per pound and keep their heat.

The bigger natural warming 56 million years ago saw temperatures rise 5.8 degrees Celsius or more probably from giant belches of methane from dead plants and animals that had accumulated on the sea floor, said Princeton University climate scientist Michael Oppenheimer.

### **Shell to expand into renewable in India**

Royal Dutch Shell is looking at opportunities in India to build its renewable energy portfolio, especially in light of the country's renewable energy targets to be achieved over the next decade, according to Mark Gainsborough,

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executive vice- president, New Energies, Royal Dutch Shell.

“India has a very ambitious target for the growth of the renewable sector,” Mr. Gainsborough told The Hindu during a clean energy forum organised by Shell during its ‘Make the Future Singapore’ event.



“I think India is a really important market for renewables in the future. There is a huge opportunity there. There is a lot of coal being burnt there, which is a challenge and we are interested in looking at opportunities in India.” “We already have a presence in the oil and gas business and potentially there is a good opportunity for us in the synergy with renewables,” Mr. Gainsborough added.

“It is one of the biggest growth markets in terms of growth in demand in power. So anybody who is interested in power will be interested in India,” he said.

#### **Storage technology**

One of the key issues with renewable energy, Mr. Gainsborough added, was that storage technology is currently not up to the mark.

“Batteries have a long way to go. To be cost-effective storage, there needs to be a lot of work,” he said.

“The lithium ion batteries we use are good for only very short duration storage. And what you need is much longer storage.”

Speaking at the forum, John Abbott, downstream director and executive committee member, Royal Dutch Shell, spoke about the critical role gas will play in India’s energy mix in the coming years.

“Gas will play a very important role in helping India reach its aim of achieving 40% of its energy from renewables and clean sources by 2040,” Mr. Abbott said.

“And biofuels will be key to the transport sector. Gas is cleaner during burning than coal and is the perfect partner for renewables. It is flexible and abundant.”

Mr. Abbott said that Shell had planned to reduce its carbon emissions at its retail outlets by 50%, although he did not specify a timeframe for this.

( The correspondent is in Singapore at the invitation of

Shell )

#### **Stayzilla — what lies beneath the ecosystem**

Dispute raises questions on access to working capital for start-ups, prevailing sense of fairness

Even as the arrest of Yogendra Vasupal, founder of start-up firm Stayzilla, on charges of non-payment of dues to its vendor, has seen the entire start-up ecosystem fuming, the demand for an environment that provides for a collateral-free working capital assistance of a specified limit is gaining ground.

Such assistance could be made available through organised banking channels, said investment banker S. Ramabadrhan. According to him, a Stayzilla-like episode could have been avoided if the start-up had had access to working capital funding.

Observers said that the happenings at Stayzilla also reflect the absence of a proper foundation for the start-up ecosystem to effectively address the ups and downs of business. The Stayzilla imbroglio, they point out, also underscores the need for educating the entire set of stakeholders in the start-up ecosystem — right from investors to entrepreneurs and vendors besides the law-enforcing authorities — on their rights and responsibilities.

#### **Big picture**

In this instance, the arguments have been restricted only to whether it is a civil or criminal dispute. However, one needs to look at the larger picture - the issue of accountability, role of private equity players and the available mechanism to settle such disputes.

On one side of the dispute is a company which has raised \$30 million from private investors and which recently announced that it would shut down and revamp its business model. On the other is an unfunded media agency start-up Jigsaw, which is desperate to get back its dues.

While questioning the choice of the law to be enforced in this instance, Aarthi Sivanandh, Partner, JSA, a legal firm, wondered if the investors could not have bailed the entrepreneur out of an ugly situation.

The episode has forced the funded start-up fraternity to close ranks. Will this prompt more vendors to take criminal action against failing start-ups? This fear must be seen in the context of a recent trend. According to data from start-up tracker Tracxn, 314 start-ups downed shutters in 2016. The count is 5 so far in 2017.

According to Kartik Maheshwari of Nishith Desai Associates, a law firm, closing down operations or posting a blog entry will not help Stayzilla escape liability arising





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from outstanding obligations. Under law, even if Stayzilla were to undergo voluntary winding up, it would have to first set off its liabilities towards creditors, he says. A civil case to claim unpaid monies stretches for years before a final order is passed. Given this, an increasingly large number of individuals are now choosing to file criminal cases alleging fraud, he says. "Irrespective of the veracity of the claims made by both the parties, technically there is nothing in the law that prevents a person from pursuing criminal action in cases where there is an alternative civil remedy available," he added.

Lawyers aver that there are no quick-fix solutions in such disputes as the current legal process is cumbersome even though it allows for winding-up. The upcoming Insolvency and Bankruptcy Code could go a long way in addressing such situations.

"Parties could consider building in alternative dispute resolution mechanisms such as arbitration in their contracts as these are gaining popularity due to heavy backlog of cases in civil courts," according to Sharanya Ranga, Partner, Advaya Legal. "Also, try to clear dues to the greatest extent possible — whether it is employee salaries, vendor payments or office rents. However, this may not solve the issue of intimidatory criminal filings," she said.

Now most start-ups prefer having a structure of private limited companies or limited liability partnerships, when compared with proprietorship concerns as prevalent in the early 1990s, according to Nishit Dhruva, managing partner, MDP & Partners. The private limited company or limited liability partnerships structure helps promoters limit their liabilities.

Serial entrepreneur Chandu Nair said that promoters should not forget their moral responsibilities towards settling liabilities, even if the company structure gives leeway. "There seems to be a culture of supporting and celebrating the funded start-ups when compared with the unfunded ones. Also, the war is between the new-age versus traditional companies. A CIBIL-like system to measure credibility of the organisation as well as the founder should be explored," he said.

#### **Tranche funding**

According to Mr. Dhruva, Stayzilla is a prime example of a start-up malfunction and not meeting with its vendor obligations. "The funding structure of such start-ups entails tranche funding from venture capitalists whereby the start-up broadcasts the funding figures even before the capital is received. However, with VCs placing pre-conditions to be met for such disbursements, the funding does not accrue in toto. This creates an uncertain envi-

ronment in the start-up ecosystem which inflates the apparent creditworthiness of a start-up," he said.

Prabhakar Mundkur, Chief Mentor, HGS Interactive Solutions, said that media agencies enjoy wafer-thin margins and non-payment from clients affected their reputation badly. "May more ad agencies be as tough with their clients? A long time ago, political parties drowned a few Indian agencies by defaulting on media payments. Then the ad agencies took a stance with political parties: to accept business only on advance payments. The ad agencies should perhaps be doing the same with start-ups," he added. A start-up ecosystem that practices fairness is what is needed now.

#### **'Unparalleled' number of dinosaur tracks discovered**

An "unprecedented" 21 different types of dinosaur tracks have been found on a stretch of Australia's remote coastline, scientists said, dubbing it the nation's Jurassic Park.

Palaeontologists from the University of Queensland and James Cook University said it was the most diverse such discovery in the world, unearthed in rocks up to 140 million years old in the Kimberley region of Western Australia.

Steve Salisbury, lead author of a paper on the findings published in the Memoir of the Society of Vertebrate Paleontology, said the tracks were "globally unparalleled".

#### **Non-avian dinosaurs**

"It is extremely significant, forming the primary record of non-avian dinosaurs in the western half of the continent and providing the only glimpse of Australia's dinosaur fauna during the first half of the Early Cretaceous Period," he said.

"It's such a magical place — Australia's own Jurassic Park, in a spectacular wilderness setting."

He added, "Among the tracks is the only confirmed evidence for stegosaurs in Australia. There is also some of the largest dinosaur tracks ever recorded."

It was almost lost, with the Western Australian government in 2008 selecting the area as the preferred site for a massive liquid natural gas processing precinct.

Alarmed, the region's traditional Aboriginal custodians, the Goolarabooloo people, contacted Mr. Salisbury and his team to officially research what they knew was there. They spent more than 400 hours investigating and documenting dinosaur tracks in the Walmadany area.

"We needed the world to see what was at stake," Goolarabooloo official Phillip Roe said, explaining the dinosaur



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tracks formed part of a songline that extends along the coast and then inland, tracing the journey of a Dreamtime creator being called Marala, the Emu man.

#### **Social life and ecology**

Aboriginal Australians have developed and are bound by highly complex belief systems — known as the Dreamtime — that interconnect the land, spirituality, law, social life and care of the environment.

A songline is one of the paths across the land which mark the route followed by localised “creator-beings”, stories that have been handed down through the generations.

“Marala was the Lawgiver. He gave country the rules we need to follow. How to behave, to keep things in balance,” Mr. Roe said.

#### **National Heritage status**

The area was eventually awarded National Heritage status in 2011 and the gas project subsequently collapsed. “There are thousands of tracks around Walmadany. Of these, 150 can confidently be assigned to 21 specific track types, representing four main groups of dinosaurs,” Mr. Salisbury said.

“There were five different types of predatory dinosaur tracks, at least six types of tracks from long-necked herbivorous sauropods, four types of tracks from two-legged herbivorous ornithomids, and six types of tracks from armoured dinosaurs.”

Most of Australia’s dinosaur fossils have previously come from the eastern side of the vast country.

### **Bird lovers help scientists uncover secrets behind evolution of beaks**

When the ancestors of Darwin’s finches arrived on the Galápagos 2 million years ago, they gained access to a world of new morsels, untapped by other animals. In a relatively short period, 14 species of finches evolved, specializing in different diets through different beak shapes: short for crushing seeds, sharp for catching insects, long for probing cactus flowers and so on.

This rapid diversification in the presence of new opportunity is called adaptive radiation. Studies of small island bird and lizard populations describe a fast burst of evolution, followed by a slowdown. But broader research has failed to find this fast-then-slow pattern of evolution on a global scale.

#### **Adaptive radiation**

An international team of researchers set out to investigate this seeming paradox through a particular trait: the shapes of birds’ bills. Analysing more than 2,000 species of birds, the researchers suggest in a report published

in *Nature* that even though evolution does not slow down globally, the theory of adaptive radiation holds up.

In the case of birds, it is not that evolution slows over time, but rather it switches from generating major changes in beak shape to producing smaller iterations of the same basic shapes, said Gavin Thomas, a professor of animal and plant sciences at the University of Sheffield in Britain and an author of the paper. In their study, Mr. Thomas and collaborators collected 3D scans of bird beaks from museum specimens representing more than 97 percent of present-day birds.

Through a website called Mark My Bird, they asked the public to help mark out specific features on the scans, including the tip, mid-line and curvature of each bill.

By combining these beak shape measurements with the latest DNA-based evolutionary trees, the scientists were able to infer ancestral bill shapes and rates of evolution going back more than 80 million years. Their data suggested that most of the variation we see in beaks today evolved long ago, in a relatively short period of time.

“Very early on, in the first 20 million years or so of modern bird evolutionary history, you develop a wide range of bird morphologies, with all kinds of extremes,” Mr. Thomas said.

After this early proliferation, the scientists believe, there was a switch to fine-tuned evolution, which can still be fast-paced.

In Hawaii, a single ancestor exploded into at least 54 species of colourful songbirds called honeycreepers. In Madagascar, 22 species of vanga birds emerged. Catastrophes like volcanic explosions possibly opened up opportunities for local evolution as well.

“In these cases, we find high rates of evolution, meaning when we compare sister species, they tend to be very different from one another,” Thomas said. But often, the different bill shapes that evolve are similar to those that already exist elsewhere in the world.

#### **Earliest variations**

This explains how, even though beak forms experienced the greatest increase in variation in the early days of birds, rates of evolution stayed relatively stable through time: Isolated groups can still evolve rapidly, just without adding much that is substantially new to the range of bill shapes found around the world.

A remaining question is why bird beaks have not diversified much beyond the same major forms, said Luke Harmon, a professor of biology at the University of Idaho who was not involved in the research. It may be that genes constrain how birds can develop, or that the niches birds



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could fill with different beaks are already occupied by other animals.

“This is one of the first studies to build on these huge trees of bird evolutionary relationships, and to lay upon them the story of this key structure, the beak,” said Bhart-Anjan Bhullar, an assistant professor of geology at Yale University who did not participate in the research.

### Butterfly find enriches Indian faunal diversity

Marking an important addition to India’s rich wildlife, researchers have described *Limenitis rileyi*, a butterfly spotted in Arunachal Pradesh three decades ago as the first record of the species in the country.

London-based naturalist Purnendu Roy told *The Hindu* that he had found a single male species in July 1987 from Upper Dibang Valley in Arunachal Pradesh at an altitude of about 1,800 metres.

Mr. Roy said that in 1987, there was no Internet and information on butterfly species was not widely available in the public domain. H.C. Tyler, who described the species in the 1940s in north-east Myanmar, did not describe it in great detail.

**Tentative identity**

Due to lack of information, Mr. Roy had tentatively identified his find as a species related to *Limentis rileyi* that is found in Myanmar and China.

Now, he has described it in detail in a paper in the latest edition of *Journal of Threatened Taxa*. The species has previously been recorded in south-eastern Tibet, Myanmar and northern Vietnam.

It was only after taking expeditions to Arunachal Pradesh with another naturalist Sanjay Sondhi a few years ago, that Mr. Roy approached the British Natural History Museum to identify the butterfly that he had found in 1987. He found that it was the first record of *Limentis rileyi* in India. Over the past few years the forest of Arunachal Pradesh, sharing borders with Myanmar, China and Bhutan, has been the site for identifying new species of butterflies or first records in India.

In 2013, Mr. Roy identified a new species of butterfly, *Callerebia dibangensis*, named after Dibang valley from where he collected the specimens.

#### **Difficult to access**

Naturalist Sanjay Sondhi said that the Dibang wildlife sanctuary is a remote area, very difficult to access but rich in biodiversity.

“There has been no sustained biodiversity assessment and if it is done it will reveal interesting details,” said Mr.

Sondhi, a trustee of the Dehradun based Titli Trust.

Mr Sondhi, who has worked extensively in the western part of Arunachal Pradesh, said that over the past few years he had found at least two additions to Indian butterflies: the Tibetan brimstone and the Ludlow Bhutan glory. The Tibetan brimstone, a sub-species seen just once before in history, that too in China-occupied Tibet by British naturalist Frank Ludlow in 1938, was located in 2013 at Eaglenest Wildlife Sanctuary in West Kameng district of the State.

The Ludlow Bhutan glory, which was thought to be exclusive to Bhutan, was found at Eaglenest Wildlife Sanctuary in 2012.

In 2015, scientists discovered a tiny butterfly from Changlang district of Arunachal Pradesh and named it the banded tit (*Hypolycaena narada*).

### Weather officials to study possible emergence of El Nino

Meteorologists are likely to review the threat to the Indian monsoon from a possible El Nino. Scientists from the India Meteorological Department, Indian Institute of Tropical Meteorology and the Ministry of Earth Sciences are expected to meet in Pune later this week to analyse a range of forecasts from international climate models – and their own – that suggest waters are likely to warm and change wind patterns enough to El Nino-like conditions. El Nino refers to an anomalous heating up of the waters in the central-eastern regions of the equatorial Pacific and implies a consistent, average rise in temperature of 0.5 degree Celsius above normal. Historically that translates to the monsoon drying up over India six out of 10 years. In the normal course of events, the Pacific waters ought to have been in the converse cool, La Nina mode and only begin a warming trend late after India’s summer monsoon period of June-September.

However these trends are expected to begin around March and – the part that’s still contentious – have an El Nino during the latter half of the monsoon.

Meteorologists however say it’s too early to be sure of an El Nino and its impact on the monsoon.

### Deep sea mining gets a second look

The risk of running out of rare earth metals that are essential to modern technology has led to a surge in interest in mining the deep seas.

But fears have also mounted about the environmental impact of disturbing vast areas of the pristine ocean floor, experts said at the American Association for the Advancement of Science annual conference in Boston. De-





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mographic growth and the acceleration of technological innovations in the past 40 years have doubled the quantity of minerals extracted worldwide, leading to shortages of certain key metals, according to a recent UN report.

"Mining is essential for modern life," said Thomas Graedel, professor emeritus of industrial ecology and chemical engineering at Yale University. "If global development proceeds at its current pace, traditional land-based supply of resources may be challenged to meet demand."

When it comes to copper, an essential element for electrical equipment and numerous industries, a shortage could begin around 2050, he said. This uncertainty highlights the importance of considering deep-sea mining, even though the process involves environmental risks.

Given the risks to fragile ecosystems, a new international approach to managing mineral deposits should be put in place, said a recent report published in *Science*. "Waters deeper than 200 meters make up 65% of the world's oceans, and are vulnerable to human activities," it said.

### Two endangered plant species spotted

In a major breakthrough in eco-conservation, forest officials in Munnar have spotted two critically endangered *impatiens* plant species on the peripheries of the Eravikulam National Park.

*Impatienses*, also called jewel weeds, are seen in pristine forests where moisture content and relative humidity are high. The Eravikulam National Park and the Mankulam forest division are surrounded by sholas. Two new species of balsams (*impatiens*) have been discovered by the officials from the shola forests on the periphery of the park and Mankulam with the help of scientists.

The Munnar-Mankulam landscape is famous for *impatiens* varieties, one of which was *Impatiens travancorica* that was spotted sometime ago.

One of the new plants, *Impatiens panduranganii*, was first noticed in 2015 by Prasad G., wildlife warden of Munnar, during a research on *impatiens* in the Pettimudi area. It is similar to *Impatiens travancorica*.

Talking to *The Hindu*, Mr Prasad said the number of species then spotted was very low due to the unscientific road construction to Edamalakudy.

Only below 35 plants with flower could be found in 2015. In 2016, when Prabhu Kumar of Kottakkal Arya Vaidyasala visited Munnar, there were about 200 and 300 of the plants, which were named *Impatiens panduranganii*.

### Poison in the air, struggle on the road

Just 117 hours into 2017, London breached its annual air

pollution limits, as a busy city artery saw nitrogen dioxide levels soar. While it was not the first time that a main city road had breached the limits so rapidly, the development brought into focus an issue plaguing almost every major city across the world.

London is a world away from the filthy, fog-thick city portrayed by authors like Charles Dickens and Sir Arthur Conan Doyle. This was largely due to the air pollution legislation after a terrible period in 1952, when, at the height of winter, a toxic fog encompassed the city, killing an estimated 12,000 people over three months. However, the gains made have been overshadowed by new forms of pollution from vehicles. "We are dealing with pollution that comes from traffic and stays in the air for a long time and can spread between many cities," says Dr. Gary Fuller of King's College London (KCL). In 2015, pollution in many areas of London was twice the level of maximum targets meant to be met in 2010.

Earlier this year, Britain was one of the five European nations to be warned by the European Commission for breaching air pollution limits. According to KCL, air pollution caused 9,416 premature deaths in the city in 2010 alone. The Mayor has already introduced a new pollution warning system — using public signs and even text messaging — and earlier this year warned of a "public health emergency". Anti-pollution masks are becoming a less uncommon sight, while schools in the most polluted parts of the city are to be subject to toxic air "audits".

"It's staggering that we live in a city where the air is so toxic that many of our children are growing up with lung problems," London's Mayor Sadiq Khan said last week as he introduced a new measure to combat pollution: a £10 a day charge on the oldest, most polluting vehicles coming into London. This will be on top of the congestion charge already payable for journeys into the city centre.

#### Mixed response

Mr. Khan's strategy has had a mixed response, with some warning that the charge would hit the poorest the hardest. Others say it does not go far enough, pointing to initiatives in cities such as Paris, which has banned the most polluting vehicles entirely from the centre. Madrid has brought in a system for banning half the cars on alternate days. Still, Mr. Khan's efforts — which have included expanding low emission zones that charge polluting commercial vehicles, and moving more and more of its public buses off diesel— have been more ambitious than those of his predecessor, says Laurie Laybourn Langton of the Institute for Public Policy Research (IPPR).

A major point of contention has been diesel. Like much of

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Europe, Britain embraced diesel as a source of fuel for both commercial and private vehicles, helped partly by government incentive programmes and the perception that it was less polluting. Now diesel alone accounts for around two-fifth of London's air pollution, estimates Mr. Langton.

The IPPR and several other organisations, as well as Mr. Khan, have called for a nationwide scheme to help people move off diesel vehicles, but there is little sign of the Centre's movement on that.

London's challenges demonstrate how even progressive policies can leave a thriving city struggling to contend with toxic air. "If we just focus on what is coming out of the exhaust pipe, it will have the least benefit for society," says Dr. Fuller. "You'll still get the particulate matter from the wear and tear of traffic and roads. You need active policies that encourage changes in behaviour too."

### Black rhinos on the brink of extinction

As the value of rhinoceros horn touches \$65,000 per kg, poaching has begun to drive the African black rhinoceros to "the verge of extinction" - not just by reducing its population size, but by erasing 70% of the species' genetic diversity - says a research paper published recently in Scientific Reports.

Genetic variation is the cornerstone of evolution, without which there can be no natural selection, and so a low genetic diversity decreases the ability of a species to survive and reproduce, explains lead author Yoshan Moodley, Professor at the Department of Zoology, University of Venda in South Africa.

Two centuries ago, the black rhinoceros - which roamed much of sub Saharan Africa - had 64 different genetic lineages; but today only 20 of these lineages remain, says the paper. The species is now restricted to five countries, South Africa, Namibia, Kenya, Zimbabwe and Tanzania. Genetically unique populations that once existed in Nigeria, Cameroon, Chad, Eritrea, Ethiopia, Somalia, Mozambique, Malawi and Angola have disappeared.

The origins of the 'genetic erosion' coincided with colonial rule in Africa and the popularity of big game hunting. From the second half of the 20th century, however, poaching for horns has dramatically depleted their population and genetic diversity, especially in Kenya and Tanzania.

#### Museum collection

For the study, scientists used genetic data obtained from existing animals and museum samples (rhinoceros parts preserved in museum collections).

The paper calls for "a complete re-evaluation of current conservation management paradigms" for the black rhinoceros. "By identifying the genetic units remaining for surviving rhinos, we are effectively defining the boundaries within which management (be it translocations to increase genetic diversity or consolidation of populations for more effective protection) can be carried out without negatively affecting the gene pool," co-author Michael W. Bruford, Professor at Cardiff School of Biosciences, Cardiff University, U.K told The Hindu.

Greater the genetic diversity, the better is the population's ability to respond to pressures such as climate change and diseases, said Prof. Bruford. "Thus the loss of so much evolutionary potential in the black rhino is worrying for its future adaptability."

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## HEALTH AND MEDICINE

### Natco Pharma unveils Hepatitis C drug in Nepal

Natco Pharma has unveiled a generic version of Sofosbuvir 400mg/Velpatasvir 100mg fixed dose combination in Nepal. It will market the product under the VELPANAT brand name and priced at Rs.25,000 equivalent for a bottle of 28 tablets in Nepal. The exercise is under a non-exclusive licensing agreement that Natco has with Gilead Sciences Inc. to make and sell generic versions of the latter's chronic hepatitis C medicines in 101 developing countries. The fixed dose combination is sold by Gilead Sciences Inc. under the Epclusa brand name.

### TB institute warns against use of new drug

Uncertainty continues to shroud the fate of 18-year-old girl suffering from extensively drug-resistant tuberculosis (XDR TB) who is waiting for the drug Bedaquiline (BDQ). The National Institute of Tuberculosis & Respiratory Diseases (NITRD) told the Delhi High Court that the drug could not be administered without proper tests as it might lead to the TB-causing bacteria becoming further drug resistant and may spread to the community and have catastrophic effects.

The Institute said, "It is wrong to suggest that conducting Drug Susceptibility Testing and waiting for its results is merely a bureaucratic requirement. It is absolutely essential to study the drug resistance of the bacteria in the patient's case so as to formulate the right BDQ containing regimen lest the bacteria become BDQ resistant and spread in the community."

The Centre, meanwhile, sought two more days to file its affidavit.

The NITRD's statement was filed before Justice Sanjeev Sachdeva, hearing the plea of the girl's father, who claimed that BDQ, manufactured by U.S. pharma major, Janssen Pharmaceutica, was the only option to save his daughter.

#### **Limited availability**

The court had asked the NITRD whether the patient could be administered BDQ without further tests. BDQ is available through limited sources in India, one of which is the NITRD in Delhi.

While the petitioner had relied upon the opinion of Dr. Jennifer Furin, PhD Lecturer in Global Health, who claims to be an international expert in the field of HIV and TB, to say that the girl satisfies the requirement for administration of BDQ, the NITRD has contradicted the claim.

Contradicting Dr Furin's claim that administering BDQ would curb the potential spread of XDR TB, the NITRD said: "If BDQ is given with an inefficient backbone regimen, the patient is likely to fail the treatment and develop an additional and fatal resistance to BDQ which may spread to the community and have catastrophic effects."

#### **"Efficacy and effects"**

On the petitioner's concerns about delayed rollout of BDQ in India, the Institute said: "It is a new drug discovered after five decades of research on TB treatment and its efficacy and effects are still being evaluated and therefore, it is being rolled out in a phased manner to avoid its misuse, development and spread of fatal BDQ resistant bacteria in the community."

The Institute said the girl cannot be simply provided BDQ as the same is provided to the Institute from the government bodies.

### Lupin to market Eli Lilly's new insulin in India

Lupin Ltd. has entered into an agreement with Eli Lilly and Co. (India) Pvt. Ltd. to market and sell Eg-lucent, a new brand of Lilly's rapid-acting insulin





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analog Lispro, through its own field force in India. Lilly will be responsible for manufacturing and import. As per the agreement, Lilly will continue to sell Lispro under the brand name Humalog, through its existing channels. Lupin, in July 2011, collaborated with Lilly to promote and distribute Lilly's Humulin products in India and Nepal. Eglucent is indicated for treating patients with diabetes mellitus. It is an injectable medication designed to improve blood sugar control in patients with type 1 and 2 diabetes.

### Indian researchers adopt novel approach to drug discovery

Researchers from the International Centre for Genetic Engineering and Biotechnology (ICGEB), Delhi have found a novel route to discover new drug targets and potential drugs for parasites such as *Loa loa* nematode (roundworm) and *Schistosoma mansoni* platyhelminths (flatworm) that cause several diseases. The results were published in the journal PLOS Neglected Tropical Diseases.

Both these parasites are the cause of major health burden, particularly in African countries. There are limited treatment options and there is the threat of drug resistance. There also little interest in developing drugs for these diseases by pharmaceutical companies as they do not stand to benefit much commercially.

#### Genetic codes

Instead of blindly screening molecules, which takes a long time and is expensive, a team led by Dr. Amit Sharma from the Molecular Medicine Group at ICGEB looked at Aminoacyl-tRNA synthetases (aaRSs) of the two parasites.

The aaRSs are vital enzymes that decode genetic information and enable protein translation. "The reason why we chose the tRNA synthetase enzyme family is because it is highly conserved [genomic similarity] in malaria and other parasites, including *L. loa* and *S. mansoni*," said Dr. Sharma, the corresponding author of the paper.

The novel approach of looking at the conserved re-

gion of the parasites is direct, quicker and cheaper. The aaRSs enzyme family has 20 members and each one of the enzymes contributes to protein synthesis. Even if one of the 20 enzymes is missing then protein synthesis cannot happen.

"We have elaborated all the critical aaRS enzymes that contribute to protein synthesis," he said.

In a next step, the team picked up one of the enzymes and validated it as a drugable target. For that purpose, the enzymes were recombinantly produced and their activities were studied.

"Cladosporin, a very potent compound that targets the malaria parasite in both blood and liver stages, seems to inhibit the enzymes of the *L. loa* and *S. mansoni* with high potency," Dr. Sharma said.

The researchers studied the crystal structure of the enzyme with cladosporin. This revealed how tightly the drug binds within the active site of the enzyme.

The researchers could understand the active sites of the enzyme and how the drug inhibits their enzyme activity.

The researchers found the drug compound to be a "very potent inhibitor" of essential enzymes in *L. loa* and *S. mansoni*.

It is also possible to use the compound to target the tRNA synthetase enzyme family of other parasitic worm diseases.

### Penicillin mould created by Fleming sells for Rs. 97.5 lakh

Microbes preserved in a glass case that features the doctor's writing on the back

How much is an old, dried out piece of mould worth? Apparently more than £11,875 (Rs. 97.5 lakh) if it was created by the doctor who discovered penicillin. The nearly 90-year-old swatch of mould has a rather extraordinary history. It came from the laboratory of Dr. Alexander Fleming whose revolutionary discovery brought the world its first antibiotic, credited with saving millions of lives worldwide.

The patchy bit of mould from his niece's collection



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was auctioned in London. The buyer was not identified. The mould is preserved in a round glass case and features an inscription by Fleming on the back, describing it as “the mould that first made penicillin.”



That, however, may be a stretch. The Scottish-born doctor likely made at least dozens of such mould mementos, derived from his original sample of the fungus.

Fleming “sent these samples out to dignitaries and to people in the scientific world, almost as a kind of holy relic,” said Matthew Haley, director of books and manuscripts at the auction house Bonham’s.

#### Miracle drug

Before the discovery, infections like pneumonia and rheumatic fever were almost death sentences.

“When it first became available, penicillin was called a miracle drug,” said Kevin Brown, archivist at the Alexander Fleming Laboratory Museum. “Its discovery began a new, life-saving era in medicine.”

In some ways, the discovery was accidental. Fleming found mould growing in an experiment when he returned to his cramped lab after a stay at his country house.

One petri dish was full of bacteria except for an area where mould was growing. He later realized the mould — a rare strain of penicillin — was killing off the bacteria around it. He suggested that it might be used as an antiseptic in wounds, and published an account of this work in 1929.

“Fleming noticed something that other people would have missed and saw the potential of penicillin to

treat patients,” said Mr. Brown.

However, Fleming couldn’t find a way of extracting enough of the penicillin to be of therapeutic use without it becoming ineffective. Scientists at Oxford University further developed penicillin, and production was ramped up so that enough of the antibiotic would be available for the Allied invasion in 1944. Fleming and Oxford scientists Ernst Boris Chain and Howard Walter Florey were awarded the Nobel Prize in medicine in 1945.

Brown noted that not everybody was thrilled to receive the preserved mould medallions and that some got multiple copies, including Queen Elizabeth’s husband, Prince Philip. “Every time he met Fleming, he got another one of these things,” Mr. Brown said.

### U.S. nixed India’s plea on reforms in medicine

A month after the 140th World Health Organisation’s (WHO) Executive Board meeting, a Freedom of Information Act (FOIA) response has revealed that the United States government had opposed including agenda items proposed by India, which aimed at reforming medical innovation that currently pump up drug prices to unaffordable levels.

The Indian government — along with 10 South East Asian countries — had proposed a discussion on an ‘Access to Medicines’ report by the United Nations High Level Panel that had recommended reforms in the funding of biomedical research and development.

However, the set of documents released by Knowledge Ecology International (KEI), a not for profit organisation that gives technical advice to governments, reveals that both the United States and the WHO opposed including the proposal by India.

#### Email exchange

An email exchange dated September 28, 2016, between Dr. Thomas Frieden, CDC Director and Vice-Chairman of the WHO EB, and Ambassador Jimmy Kolker, Assistant Secretary for Global Affairs at the



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U.S. Department of Health and Human Services, sets out the position of the U.S. government, stating that, “Access to medicines (oppose proposal by India): The USG should be on the record opposing this proposal from India that seeks to take forward recommendations from in the U.N. Secretary General’s High Level Panel on Access to Medicines report, which was released in September. We have serious concerns about the narrow mandate of the Panel and its recommendations ...”

The 11 member-states — Bangladesh, Bhutan, South Korea, India, Indonesia, Maldives, Myanmar, Nepal, Sri Lanka, Thailand, and Timor-Leste — as well as Brazil, Iran, and South Africa supported the inclusion of the agenda item.

The delays by WHO to place the UN HLP recommendations on the agenda of the WHO’s EB and subsequently at the World Health Assembly have drawn widespread criticism from Asian civil society organisations.

“The U.N. report says there is a need for an RD treaty and it recommended reforms in the area of biomedical R&D. The U.S. government has a policy of blocking all reforms that would lead to funding the R&D system in a way that it prioritises diseases that kill millions of people in the developing world. The U.S. government is not just a member-state of WHO but also a big donor. This is consistent with the U.S. policy to pressure countries like India to have more IP barriers while blocking all attempts at reforms,” said Leena Menghaney, lawyer and access campaigner.

#### **Policy incoherence**

The U.N. Access to Medicines report had recommended solutions for remedying the policy incoherence between justifiable rights of inventors, trade rules and global public health targets. The report recommended that “governments and the private sector must refrain from explicit or implicit threats, tactics or strategies that undermine the right of WTO Mem-

bers to use TRIPS flexibilities.”

On March 1, India delivered a statement during WTO TRIPS Council discussions on the Access to Medicines report, urging member-states to discuss the report’s recommendations.

This article has been corrected for a factual error.

#### **India runs out of life-saving HIV drug for children**

The letter, written on March 4, is signed by 637 children ranging from ages 3 to 19 and states that, “the pharmaceutical company Cipla has in various forums cited delay in payments by the national programme for the HIV medicines by several years and even non-payment of its dues in many cases. Profits on child doses of HIV medicines are small and delayed payments are having a chilling effect on the ability of the National AIDS Control Organisation (NACO) to convince the company to participate in the bids it invited annually.”

Stocks of Lopinavir syrup — a child friendly HIV drug — ran out after Cipla, the sole manufacturer of the drug, stopped manufacturing it over the issue of non-payment from the Health Ministry. Cipla is the dominant player in the Indian market across the HIV segment and has not stopped participating in government tenders after the Health Ministry failed to pay Cipla for consignments sent in 2014.

#### **Emergency tender**

Faced with a crisis, the Health Ministry says it has instructed State AIDS Control Societies (SACS) to purchase from local markets. “An emergency tender has been placed but we have instructed SACS and State Governments to purchase from local markets,” said Arun Panda, Additional Secretary, Health Ministry.

However, since the syrup has gone out of production, they are not available in retail markets. “Across the country, in every State, there is no one to make this drug. How can we buy this from retail shops?





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The sole producer is not manufacturing it,” said Paul Lhungdim of DNP+.

While Cipla has declined to comment, emails made available to The Hindu reveal that Cipla asked for guarantees of payment from HIV patients. In an email exchange between Umang Vohra, Chief Executive Officer (CEO), Cipla Pharmaceuticals, and patient-activist Loon Gangte, Mr. Vohra states that, “Cipla has always stood for the patients — not just in India but also all per the World (sic). Quite naturally, we also expect that issues regarding payments are also addressed expeditiously,” indicating that Cipla will not move from its stand until either Global Fund or the Indian government settles the bills.



The heated three-way communication between Cipla, the Indian government and the HIV community ended on March 4, with an email being marked to the entire top brass of Cipla Pharmaceuticals, Indian government officials and Clinton Health Access Initiative (CHAI) with Mr. Loon Gangte, making it clear that he was “in no position” to guarantee payments. Mr. Gangte writes that he had “been told by officials in Cipla that we should ensure payment for any future procurement of the medicine from Cipla. I would like to tell you that the community is in no position to do so. We can neither force the government nor donors like the Global Fund. But at the end of the day, we are the ones who are hit by these shortages and stock-outs.”

Experts say the critical shortages are proving to be both tragic and embarrassing for India’s HIV pro-

gramme. “The government is abdicating its constitutional responsibility to make available life saving medicines for the HIV community. It is also unfortunate that the present management of Cipla is walking away from its commitment to access to medicines all over the world, for which they are globally renowned,” said Anand Grover, Senior Counsel at Lawyers Collective’s HIV/AIDS Unit.

For the HIV-infected children, the letter to Mr. Modi, Finance Minister Arun Jaitley and Health Minister JP Nadda is a last resort. “We humbly request you to look into the matter of HIV drug stock out, in general, and in particular paediatric HIV medicines to ensure that they are not merely exported but also actually available to the children in this country.”

### Global fund to help solve India’s HIV drug crisis

After running out of the child-friendly HIV syrup, Lopinavir, India is likely to procure the drug from a rapid supply facility routed through the Global Fund for AIDS, Tuberculosis and Malaria (GFATM), a multilateral donor agency.

Meanwhile, the Health Ministry, released the first installment of the Rs. 6 crore payment due to Cipla Pharmaceuticals — the sole manufacturer of the drug. While the immediate crisis triggered by unpaid bills is being sorted, the shortage of the drug itself still looms large over India’s national HIV programme. India has a cohort of over 600 children who require 36,000 bottles of Lopinavir syrup annually. Speaking to The Hindu, Dr. Denis Broun, Global Director for access and public affairs at Cipla Pharmaceuticals, clarified that the company did not have a position in principle that they ever participate in government tenders. “Cipla has been supplying anti retrovirals to governments and we have been upfront with our issues of payments over the past several months. The last payment was the proverbial straw that broke the camel’s back,” said Dr. Broun.

“We did not participate in the last tender because of

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the payment issues. We understand that the government is trying to sort out the financial situation and I want to clarify that we do not have a position, in principle, that we will not participate in government bidding.”

#### **A relief**

In what is a relief to HIV community, he added that Cipla Pharmaceuticals will be re-submitting the application seeking registration of the Lopinavir pellets — a better paediatric formulation as it can be added to meals and will not require refrigeration.

The Drug Controller General of India (DCGI) is likely to give the approvals accelerated attention, given the dire shortage.

The developments follow a March 6 report by The Hindu, ‘India runs out of life-saving HIV drug for children’, that 637 children living with HIV (CLHIV) ranging from ages 3 to 19, had written to Prime Minister Narendra Modi after Cipla stopped production of the drug due to non-payment of bills from 2014. Upset with continued non-payment, Cipla Pharmaceuticals had stopped participating in government tenders, resulting in the current stock-out.

The Health Ministry has maintained that the supply of Lopinavir should resume by the end of this week, informed Arun Panda, Additional Secretary, Ministry of Health and Family Welfare.

#### **Summit sheds light on PCSK9i to reduce LDL cholesterol**

The drug lowers cholesterol by 60% when combined with statin

The recently concluded International Diabetes Summit at the city-based Chellaram Diabetes Institute (CDI) shed light on the use of PCSK9 inhibitors (PCSK9i) to lower cholesterol levels and reduce the risk of heart attacks.

The PCSK9i are a new class of injectable drugs that reportedly reduce ‘bad’ cholesterol levels by up to 60% when combined with a statin (another class of drugs prescribed to help lower cholesterol levels).

“Statins are said to reduce the risk of heart attack by 25% to 30%. These block the enzyme that control production of LDL cholesterol. However, they do not completely remove the risk of heart attacks, which makes research of new products necessary,” said Dr. Vinaya Simha, consultant, Endocrinology, and assistant professor, Department of Internal Medicine at the U.S.-based Mayo Clinic.

Low-density lipoprotein cholesterol, abbreviated as LDL-c, is considered the ‘bad’ variant of cholesterol as it contributes to plaque deposition, leading to the hardening and narrowing of arteries or ‘atherosclerosis’ (thickening of artery walls owing to accumulation of white blood cells).

#### **Function of the drugs**

The drugs inactivate a protein in the liver called proprotein convertase subtilisin/kexin type 9 (PCSK9). The protein de-activates the receptors on the liver cell surface that transport LDL into the liver for break down. Without these receptors, more ‘bad’ cholesterol remains and accumulates in the blood.

PCSK9 inhibitors may be used alone or in combination with statins to lower the ‘bad’ cholesterol levels in patients who cannot tolerate any statin drug.

Dr. A. G. Unnikrishnan, CEO and chief Endocrinologist at CDI, said, “Controlling cholesterol level with diet and exercise is important. PCSK9 inhibitors are not available in India as of now, [but] they seem to be a promising mode of reducing risk of heart attacks.”

PCSK9 inhibitors are currently under clinical trial in India.

#### **MRI twice as likely as biopsy to spot prostate cancer**

Every man with suspected prostate cancer should have an MRI scan; this is twice as likely to identify the presence of dangerous tumours as the invasive biopsy used currently, say doctors.

A major trial, which could influence a change of practice in the NHS, will amount to “the biggest leap

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forward in prostate cancer diagnosis in decades, with the potential to save many lives”, according to Prostate Cancer UK, an organisation that funds research in prostate cancer and works to promote awareness among the public, based in the U.K.

Researchers publishing in the medical journal *The Lancet* have shown that an MRI picks up 93% of aggressive cancers, compared with 48% for a biopsy.

The biopsy, which removes a sample of tissue for lab testing, often misses the tumour altogether.

The Prostate MRI Imaging Study (Promis), led by researchers at University College London (UCL), also showed that more than a quarter (27%) of all men with suspected cancer could avoid a biopsy altogether.

MRI scans were shown to be better at ruling out cancer, as well as identifying tumours that are not dangerous because they are slow growing and do not need to be treated. In the trial, the number wrongly diagnosed with a cancer that needed treatment was reduced by 5%.

“Prostate cancer has aggressive and harmless forms. Our current biopsy test can be inaccurate because the tissue samples are taken at random,” said the lead author, Dr Hashim Ahmed from UCL. “This means it cannot confirm whether a cancer is aggressive or not and can miss aggressive cancers that are actually there.

### **Chronic exposure to commonly used insecticide causes diabetes**

A study by scientists at Madurai Kamaraj University, Tamil Nadu, has found evidence that chronic exposure to organophosphate insecticides induces diabetes and impaired glucose tolerance in both humans and mice. The researchers found that organophosphate-induced diabetes was mediated by gut bacteria. The results were published in the journal *Genome Biology*.

A survey of around 3,000 people in villages in and around the university found that the prevalence of

diabetes in people who were directly exposed to the insecticides was three-fold higher than in people who were not directly exposed to the insecticide. Serum analysis for four organophosphate insecticides revealed a direct correlation between pesticide level and HbA1c. “We saw a linear trend — for every unit increase in insecticide residue there was a corresponding increase in HbA1c level,” says Dr. Ganesan Velmurugan from the Department of Molecular Biology, School of Biological Sciences, Madurai Kamaraj University and the first author of the paper.

#### **Treating mice**

To ascertain that chronic exposure to organophosphates led to diabetes, the researchers treated mice (2.9 microgram per kg bodyweight) with organophosphate for 180 days, which is equivalent to 12-15 years of human life. “We saw an increase in blood sugar level from day 60 in mice treated with the insecticide,” he says. “But we didn’t see any correlation between insecticide and neurotransmitter (acetylcholine esterase) level in mice treated with the pesticide.” The neurotransmitter is the main target of the pesticide.

So the researchers were confident that the pesticide was inducing diabetes through a new route of action. Studies have already shown that the pesticide is degraded by bacteria present in the gut. To ascertain this, the researchers collected faecal material from mice exposed to the pesticide for 180 days and transplanted it to a new set of mice.

“The mice that received the faecal material developed diabetes in just one week, while the control mice did not. We repeated the experiment thrice and got the same result,” Dr. Velmurugan says. “We concluded that organophosphate-induced diabetes was mediated by gut bacteria.”

To understand the molecular mechanism, the researchers did a complete gene profiling of gut bacteria present in mice that were exposed to the pesticide for 180 days. “We found the genes linked to organophosphate degradation were highly expressed,” he

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says. So they focussed on finding the pathway involved in the degradation of the pesticide.

#### **The pathway**

The gluconeogenesis pathway — where glucose is generated from non-carbohydrate sources such as fat and proteins — was highly expressed. “The pesticide is degraded into short-chain fatty acid, particularly acetic acid. It is well known that acetic acid produces glucose, elevated blood sugar levels and glucose intolerance,” Dr. Velmurugan says.

They ascertained the role of acetic acid in elevating blood sugar level in mice by administering sodium acetate orally and through rectal route; the rectal route led to more blood sugar increase than the oral route.

#### **Reconfirmed in humans**

The role of gut bacteria in mediating pesticide-induced diabetes was confirmed in humans by studying the faeces of diabetics. “The acetate level was higher in people with diabetes,” he says.

“The study clearly shows the prevalence of diabetic conditions mediated by microbial degradation of the pesticide in humans,” says Subbiah Ramasamy from the Department of Molecular Biology, School of Biological Sciences, MKU and the corresponding author of the paper. “So the usage of this pesticide should be seriously reconsidered.”

#### **Taking a nap: A time-tested health aid**

Sixty years ago, Ella Fitzgerald sang, “Birds do it, Bees do it.” While she meant falling in love, we can use the line just as well for sleeping. Sleep is an essential aspect of the daily life of all animals, since it offers not only rest and recuperation, but also helps the brain organise itself.

Even fish do it, albeit with their eyes open. Huge ones like the dolphin are reported to sleep for a little over 10 hours daily. Understanding the role of sleep also offers some cues about the evolution of animals, mammals and, ultimately, of us, humans. Dogs

sleep for 12-14 hours a day, but are alert even during this period (recall what the Hindu sages advised students: sleep like a dog - light and alert (swana nidra)). Higher up the evolutionary ladder, a bonnet monkey sleeps for 12 hours or more a day, a chimpanzee (closest to us humans) sleeps about 10 hours, while we sleep about 8 hours a day.

Interestingly, while bonnet monkeys sleep wherever, a chimpanzee actually makes a bed (of strewn and collected leaves and torn out branches) on the tree and cozies up to sleep for 10 hours or so. Orangutans do the same, making a new sleeping platform or bed daily, covering themselves with leaves and similar stuff, in order to avoid predators and bloodsucking insects. Dr David R Samson, of Duke University, has carefully collected and compared the sleeping hours and patterns of higher apes, hunter-gatherer humans in the African wild, and modern day humans from the U.S.

He points out to a connection between sleep (both how deep and how long) and the cognitive ability of animals, primates and man. The very fact that orangutans and chimpanzees make a bed, cover it protectively and sleep long and deep itself points to their ability to think, innovate, and arrange to protect themselves. When he monitored their sleep pattern, he found them sleeping deep, with rapid eye movements (REM) in their sleep for only 18% of the time. Now, REM indicates that the brain and body are energised due to dreaming, storing and recapitulating memories, learning and other “cognitive” acts. The rest 82% of the 10-hour-long sleep is deep and restful. Compare this with a bonnet monkey whose REM sleep is only 12% and the remaining 88% is non-rapid eye movement (NREM) sleep.

The percentage of REM sleep across species is roughly correlated with cognition, brain development and activity. This is best illustrated when we monitor human infants. The REM sleep is highest in growing infants (often up to 50%), indicating that their brains are busy collecting, collating, consoli-



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dating and using information. With age it gradually drops and becomes about 22% in people over 65 years of age. (Indeed, a similar growth-dependent behaviour in the REM sleep patterns in chimpanzees has been noted by Japanese primatologists).

What about when early humans moved from the phase of hunter-gatherers to organising themselves into groups settled in villages and invented technologies such as making fire, building houses to live in, practising farming and agriculture and so forth? As expected, the sleep-wake patterns also have changed. Dr. Samson and colleagues have been able to compare the sleeping habits of hunter-gatherer tribes in Tanzania (yes, groups such as the Hadzas, exist even today) with those of modern Western humans in the U.S. (Their paper, free access on the web, appears in the American Journal of Physiology and Anthropology, 2017; 1-10). The Hadzas live natural lives, with their daily body clocks (called the circadian rhythm) tuned to the Sun and the Moon as light sources. In contrast, we moderns use artificial light and sleep in closed environments and follow man-made daily work routines. Our body clocks are thus not natural. As Drs. Samson and Nunn write in an earlier paper (Evolutionary Anthropology 2015; 24: 225-237; alas, no free access), when they compared the sleep patterns, they found that the Hadzas slept only for about 6.25 hours every night and with a poor quality of sleep (efficiency estimated to be only 69%). In comparison, modern day humans sleep longer (8 hours) and deeper (efficiency 90-94%). The hunter-gatherer sleeps light, alert towards any disturbance such as animal threats, ambient noise, weather fluctuations and other factors – all of which we moderns are free from, thanks to our protected environments.

In a way, these early humans slept the swana nidra – alert and ready, but slept less than we would have thought they did. However, they made up for it by taking a nap every afternoon for about 90 minutes or so. This is something that we moderns need to learn and practise. Thankfully, this habit of an after-

noon nap, or siesta as it is called in Spanish, is still in vogue in parts of Europe. The organisation called the Sleep Foundation extols the benefit of an afternoon nap. They say that naps can restore alertness, enhance performance and reduce mistakes and accidents. A study at NASA on sleepy military pilots and astronauts found that a 40-minute nap improved performance by 34% and alertness 100%. If it is good for space-men, it is good for us too!

### Porcupine inhibitors of use in regenerative medicine

In a new development, researchers have found out that a cancer drug could promote regeneration of heart tissue.

An anticancer agent in development promotes regeneration of damaged heart muscle. This is an unexpected research finding that may help prevent congestive heart failure in the future.

The study findings were published online in Proceedings of the National Academy of Sciences.

Many parts of the body, such as blood cells and the lining of the gut, continuously renew themselves throughout a person's life. Others, such as the heart, do not. Because of the heart's inability to repair itself, damage caused by a heart attack causes permanent scarring that frequently results in serious weakening of the heart, known as heart failure.

For years, Dr. Lawrence Lum, Associate Professor of Cell Biology at UT Southwestern Medical Center, has worked to develop a cancer drug targeting Wnt signalling molecules. These molecules are crucial for tissue regeneration, but also frequently contribute to cancer. Essential to the production of Wnt proteins in humans is the porcupine (Porc) enzyme, so-named because fruit fly embryos lacking this gene resemble a porcupine. In testing the porcupine inhibitor, the researchers noted a curiosity. "We saw many predictable adverse effects — in bone and hair, for example — but one surprise was the number of dividing cardiomyocytes (heart muscle cells) was

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slightly increased,” said Dr. Lum, senior author of the paper, and a member of UTSW’s Hamon Center for Regenerative Science and Medicine. “In addition to the intense interest in porcupine inhibitors as anticancer agents, this research shows that such agents could be useful in regenerative medicine.” Based on their initial results, the researchers induced heart attacks in mice and then treated them with a porcupine inhibitor. Their hearts’ ability to pump blood improved by nearly twofold compared to untreated animals.

### Study links gut bacteria to Alzheimer’s

The bacteria in your gut may play a major role in the development of Alzheimer’s disease (AD), the most common form of dementia, says a study that may initiate new ways for treatment and prevention of the neurodegenerative disease.

The researchers found that mice suffering from AD have a different composition of intestinal bacteria compared to mice that are healthy.

Mice without bacteria had a significantly smaller amount of beta-amyloid plaque — lumps that form at the nerve fibres in cases of AD — in the brain.

“Our study is unique as it shows a direct causal link between gut bacteria and Alzheimer’s disease. It was striking that the mice which completely lacked bacteria developed much less plaque in the brain,” said Frida Fak Hallenius from the Lund University in Sweden.

“The results mean that we can now begin researching ways to prevent the disease and delay the onset,” Hallenius added.

Gut bacteria have a major impact on how people feel through the interaction between the immune system, the intestinal mucosa and our diet.

The composition of the gut microbiota depends on which bacteria we receive at birth, our genes and our diet, the researchers said.

In the study, the team also studied AD in mice that completely lacked bacteria to further test the rela-

tionship between intestinal bacteria and the disease. They transferred intestinal bacteria from diseased mice to germ-free mice.

The mice developed more beta-amyloid plaques in the brain as compared to if they had received bacteria from healthy mice, the researchers noted.

### Fast to reverse diabetes

A type of fasting diet may reprogramme pancreas cells, promote the growth of new insulin-producing pancreatic cells and reduce symptoms of Type 1 and Type 2 diabetes, a study has shown.

In the study, led by researchers from the University of Southern California, mice were placed on fasting mimicking diet (FMD) for four days each week.

They showed remarkable reversal of diabetes.

The mice regained healthy insulin production, reduced insulin resistance.

They also demonstrated more stable levels of blood glucose — even in the later stages of the disease, the researchers said in the paper published in the journal Cell.

The genes normally active in the developing pancreas of embryonic/foetal mice are reactivated in diabetic adult mice when cycling FMD with normal diets.

This increases production of the protein neurogenin-3 (Ngn3) and, as a result, promotes the creation of new, healthy insulin-producing beta cells.

Researchers also examined pancreatic cell cultures from human donors and found that, in cells from Type 1 diabetes patients, nutrients mimicking fasting also increased expression of the Ngn3 protein and insulin production.

“These findings warrant a larger FDA trial on the use of the Fasting Mimicking Diet to treat diabetes patients,” said Valter Longo from the University of Southern California.

“People with diabetes could one day be treated with an FDA-approved Fasting Mimicking Diet for a few days each month, eat a normal diet for the rest of

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the month, and see positive results in their ability to control their blood sugar by producing normal levels of insulin and improving insulin function,” Longo added.

### **Mumbai researchers identify a protein critical for sperm motility**

A Mumbai-based team of researchers has identified one more protein — heat shock protein 90 (HSP90) — found in human sperm that determines the ability of sperm to vigorously whip their tail and move or swim (motility) faster towards an egg to fertilise it. The reduced ability of sperm to move towards the egg is one of the causes of infertility in men. The results were published recently in *Journal of Assisted Reproduction and Genetics*.

Studying groups of infertile men to find the causes of male infertility, the researchers observed that men with poor sperm motility have very low amounts of HSP90 in the sperm. In men with a greater percentage of highly motile sperm, the amount of the protein in the sperm was higher.

#### **Two forms**

The protein is present in two forms — HSP90 alpha and HSP90 beta. While the alpha form is present in the junction between the head and mid-piece of a sperm, the beta form is found in the tail. This is the first time the presence and abundance of the two forms of the protein in certain parts of the sperm has been reported.

“HSP90 beta is dominant in the tail. So we thought the motility is regulated by HSP90 beta isoform,” says Dr. Deepak Modi at ICMR’s National Institute for Research in Reproductive Health (NIRRH), Mumbai and the corresponding author of the paper. At any time, sperm keep moving at a slow speed (basal motility) but in the presence of progesterone hormone, which is found in the female reproductive tract, the motility of sperm suddenly increases. It is this increased motility due to the hormone that helps sperm travel the long distance to reach the egg.

To ascertain whether the protein is needed for motility, the researchers used two drugs to inhibit the protein in vitro. “The basal motility of sperm was unaffected. But when we added progesterone hormone to sperm (which had the functions of HSP90 already inhibited by the drugs) we did not see sperm move faster and forward,” Dr. Modi says.

#### **Basal motility**

“HSP90 protein is not the only one that is responsible for motility. So inhibition of this protein alone may not affect basal motility. Thus we got interested in looking at the effect of progesterone-induced motility,” says Vrushali Sagare-Patil from NIRRH and the first author of the paper

While the basal motility is not dependent on HSP90, the protein is required to increase the motility of sperm when exposed to progesterone hormone. “If a man has low amounts of HSP90 protein in his sperm, the sperm will be unable to swim upwards to the tubes and fertilize the egg because it cannot feel the effects of progesterone. This will be a cause of infertility,” Dr. Modi says.

“So the progesterone-driven motility requires additional machinery. One of the components is the HSP90 protein,” he says.

#### **Drug development**

The information about the crucial role of HSP90 protein can help scientists to develop drugs to make sperm move faster and forward in the female reproductive tract in people who low sperm motility.

“At present there is no treatment for male infertility due to poor sperm motility caused by genetic causes,” says Dr Indira Hinduja an IVF expert at Mumbai’s Hinduja Hospital and a co-author of the paper. There is a possibility that this work might help the development of drugs that would help enhance sperm motility by restoring the functions of the protein.

Conversely, contraceptives can be developed to inhibit the protein so that sperm do not move faster and reach the egg to fertilise it even in the presence



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of the hormone.

### Heart attack care trial reduces deaths

A trial programme on acute heart attack care run in three districts of Tamil Nadu was able to reduce deaths by 19% over its year-long duration, according to a research paper. Indian Council of Medical Research (ICMR) during a meeting recommended that this model be adopted across the country.

The findings have been published in the latest issue of JAMA Cardiology . The trial was conducted in three districts of Tamil Nadu with a total population of 2.5 million people over a period of 47 weeks. In all, 2,420 heart patients enrolled, between August 2012 and June 2013. The study claims that it was able to “reduce patient death rates by 19% at the end of one year.”

The STEMI model has a hub hospital with a cath lab, linked to peripheral hospitals from where patients can be transferred. The model relies on three critical elements.

The STEMI Kit which enables transmission of ECGs from a peripheral hospital to the hub hospital with an on-call cardiologist is the first. The second is an ambulance service for picking up a patient from his residence and for transferring from one hospital to another. The third crucial element is BPL insurance to ensure that every patient can access this programme.

Through this pilot study, greater number of patients were administered superior therapies (primary PCI and pharmaco-invasive therapy) as compared to stand-alone thrombolysis. “The total percentage of these therapies went up from 35 to 61%,” as per the study. The peripheral hospitals saw this rate improve from “3.1 to 20.6%.” “The drop in mortality rate was primarily because of access to superior treatment strategies made available to patients at peripheral hospitals,” said Dr Thomas Alexander.

Therefore, “according to our cost-benefit analysis, for every rupee spent on this programme, the gov-

ernment will be able to save Rs 3.58,” says Dr Alexander.

According to the Management of Acute Coronary Events Registry, the median time recorded for 5,300 patients from 12-13 states between chest pain and transfer of patient to hospital is 400 minutes. Experts say this should ideally be just 60 minutes.

### Brain switch that controls blood flow

A protein “switch” within the tiny capillaries of the brain controls the blood flow that ensures optimal brain function, a new study, published in Nature Neuroscience, has found.

Researchers from University of Vermont in the U.S. have uncovered that capillaries have the capacity to both sense brain activity and generate an electrical vasodilatory signal to evoke blood flow and direct nutrients to nourish hard-working neurons. “When there is an increase in brain activity, there is an increase in blood flow,” said Thomas Longden, assistant professor at the University of Vermont. Previously, capillaries were thought to be passive tubes, and the arterioles as the source of action. Researchers have discovered that capillaries actively control blood flow by acting like a series of wires, transmitting electrical signals to direct blood to the areas that need it most. To achieve this feat, the capillary sensory network relies on a protein (an ion channel) that detects increases in potassium during neuronal activity.

Increased activity of this channel facilitates the flow of ions across the capillary membrane, thereby creating a small electrical current that generates a negative charge — a rapid signal — that communicates the need for additional blood flow to the upstream arterioles, which then results in increased blood flow to the capillaries, researchers said.

Researchers also determined that if the potassium level is too high, this mechanism can be disabled, which may contribute to blood flow disturbances in a broad range of brain disorders.

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“These findings open new avenues in the way we can investigate cerebral diseases with a vascular component,” said Fabrice Dabertrand of University of Vermont.

### **Pneumonia fighter hormone identified**

Stimulating hepcidin production in patients who do not produce it well, such as people with iron overload or liver disease, may help their bodies effectively starve the bacteria to death, said researchers, including those from the University of Virginia in the United States.

Researchers found that mice that had been genetically modified to lack hepcidin were particularly susceptible to bacterial pneumonia.

Nearly all of the mice had the pneumonia bacteria spread from the lungs into their bloodstream, ultimately killing them. “It is the exact same thing that happens in people,” Borna Mehrad of University of Virginia.

“The mice that lacked the hormone were not able to hide iron away from the bacteria, and we think that is why the bacteria did so well in the blood,” Mr. Mehrad pointed out.

#### **Hides iron**

The hormone Hecpidin is produced in the liver and limits the spread of the bacteria by hiding the iron in the blood that the bacteria need to survive and grow, said researchers.

“The rate at which these organisms become resistant to antibiotics is far faster than the rate at which we come up with new antibiotics,” Mr. Mehrad said.

The study was published in the journal JCI Insight .

### **Single-dose Zika vaccine works in animals: Study**

An innovative vaccine made from genetic material protected lab animals from the Zika virus in experiments, scientists reported, calling it a “promising” lead in fighting the threat to humans.

A single, low dose of the vaccine shielded mice exposed to Zika five months after the shot, they reported in the journal Nature.

Monkeys exposed five weeks after they were inoculated were also not affected by the virus.

“We observed rapid and durable protective immunity without adverse events,” said senior author Drew Weissman, a professor at the University Of Pennsylvania School Of Medicine.

Zika erupted on a large scale in mid-2015 and more than 1.5 million people have been infected.

### **High on hysterectomies: Losing wombs to medical malpractice**

An unusually large number of hysterectomies performed in Kalaburagi district of Karnataka has led to a State government probe, and an order suspending the licences of four hospitals.

During a 30-month period, the four institutions are said to have removed the uterus of women, often without medical justification and allegedly for entirely commercial reasons.

#### **Complaints galore**

A spate of complaints prompted the State government to form an expert committee, headed by A. Ramachandra Bairy in October 2015. Its investigation found that 2,258 hysterectomy procedures were done in 30 months in Kalaburagi district. The four hospitals at the centre of the probe — Girish Noola Surgical & Maternity Hospital, Basava Hospital, L.M Care Hospital, and Sudha Memorial Smruti Maternity & Surgical Nursing Home — were probed for alleged violation of various provisions of the Karnataka Private Medical Establishments Act (KPME) 2007 and Rules, 2009.

Based on the inquiry, Kalaburagi Deputy Commissioner Ujjwal Kumar Ghosh suspended the licences of Noola hospital in November 2016, and the other three hospitals on January 10, 2017, for six months. Mr. Ghosh wrote to the Karnataka Medical Council





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(KMC) on January 23, 2017, recommending disciplinary action against Dr. Girish Noola and Dr. Smita Noola, who conducted over 600 hysterectomies in two years, in alleged violation of law and professional ethics. The KMC has yet to take a call on this. The surgeries have left young mothers in Belamagi Lambani tanda of Aland taluk in Kalaburagi district, in rural Karnataka in a daze.

Pinku Bai married at 13, had three children by 19, and underwent a hysterectomy at 24 because her doctor warned her of “serious health complications due to a swollen uterus”. Severe abdominal pain and vaginal discharge had prompted her to seek medical help.

With the dire warning of the “Big C leading to death” ringing in her ears, she underwent a hysterectomy in November 2014, paying Rs. 30,000 with money borrowed from relatives. Today, wiping away tears, Pinku Bai says, “I agreed to the surgery as I kept thinking, what would happen to my children if I were to die?” But the procedure did not end her difficulties. She developed severe backache, weakness, prolonged tiredness, chest pain, and partial vision loss.

Many young women of the Lambani community and the Golla community went under the knife. Illiteracy, poverty and unethical doctors ‘making a fast buck’ have pushed the Pinku Bais to undergo unnecessary hysterectomies, health activists say.

In Arsikere and Kadur taluks, Chitradurga, Davanagere and Tumakuru districts, in Chincholi, Aland, Chittapur and Jevargi taluks of Kalaburagi, Yadgir and Raichur districts, there are many stories of women approaching gynaecologists with complaints of bleeding, nagging abdominal pain, or a simple urinary tract infection, only to return home without a uterus.

Omkkamma, 30, of Kolagunda gollarahatti in Hassan, had a hysterectomy four years ago after just one consultation. She was ready to do anything to get rid of the excruciating pain. Three other women from

the same village were operated upon the same day. One of them died three months later.

Lalitha Bai’s medical examination pointed to a urinary tract infection. “Noola Hospital in Kalaburagi told me I would die soon, and convinced me to have a hysterectomy. I was operated upon even though we had no money. But I was discharged only after we paid Rs. 25,000,” she recalled. Post-surgery, her infection persists and she spends hard-earned money buying drinking water, hoping it would help.

In most cases, the hysterectomies were performed without a prior medical examination, save for a sonography, the government inquiry committee found. Karnataka Janarogya Chalavali (KJC), a group of public health activists, took up the issue in 2015.

KJC activists and victims allege that the doctors identified by the probe are continuing with unwarranted hysterectomies. They demand the cancellation of the registration of the doctors and booking of criminal cases against them.

### **India needs the rubella vaccine**

#### **Why is the measles-rubella vaccine being administered to children?**

Buoyed by the elimination of polio six years ago and maternal and neonatal tetanus and yaws in 2016, India has set an ambitious target of eliminating measles and controlling congenital rubella syndrome (CRS), caused by the rubella virus, by 2020. While two doses of measles vaccine given at 9-12 months and 16-24 months have already been part of the national immunisation programme, it is the first time that the rubella vaccine has been included in the programme. Since the rubella vaccine will piggy-back on the measles elimination programme, there will be very little additional cost.

According to the World Health Organisation (WHO), “a single dose of rubella vaccine gives more than 95% long-lasting immunity.” All children aged nine months and 15 years will be administered a single dose of the combination vaccine.

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Measles is highly infectious and is one of the major childhood killer diseases. Of the 1,34,000 measles deaths globally in 2015, an estimated 47,000 occurred in India. The introduction of the second dose of the measles vaccine and an increase in vaccine coverage have led to a sharp decline in deaths in India — from an estimated 1,00,000 deaths in 2010 to 47,000 in 2015. Unlike measles, rubella is a mild viral infection that mainly occurs in children. But a woman infected with the rubella virus during the early stage of pregnancy has a 90% chance of transmitting it to the foetus. The virus can cause hearing impairments, eye and heart defects and brain damage in newborns, and even spontaneous abortion and foetal deaths. Of the 1,10,000 children born with CRS every year globally, an estimated 40,000 cases occur in India alone.

**Why opt for a campaign?**

With the target set for 2020 to eliminate measles and control CRS, there is a compelling need to create a solid wall of immunity in all children up to 15 years in one go at the earliest. That can be achieved only if immunisation is carried out in a campaign mode by targeting 410 million children nationwide within 18 months. About 465 million doses will be required. Since the Pune-based Serum Institute of India is the only manufacturer of the vaccine, the measles-rubella vaccination campaign is being introduced in phases. Karnataka, Tamil Nadu, Puducherry, Goa and Lakshadweep are covered in the first phase.

The entire country will be covered in four phases in 18 months. Following the campaign, two doses of the combination vaccine will become a part of the national immunisation programme. All children will receive the vaccine free at 9-12 months and 16-24 months of age.

**Is it possible to achieve the goal by 2020?**

According to Dr. Jacob John, co-chairman of the India Expert Advisory Group for measles and rubella, it is eminently doable. Though the goal is only to eliminate measles and control rubella by 2020, both

viruses can be eliminated if their transmission can be broken. For that to happen, the vaccine coverage has to be over 95% during the campaign and in the immunisation programme that follows it. Now the measles vaccine coverage for the first dose is about 87% and 70% for the second dose. Under the routine immunisation programme, the reach of the first dose of the measles vaccine shot up from 56% in 2000 to 87% in 2015. Furthermore, India has to ramp up surveillance of both diseases, maintain outbreak preparedness, respond rapidly to outbreaks by vaccinating all children in a community and ensure effective and timely treatment of cases anywhere in the country. According to the WHO, elimination of measles will help to achieve Sustainable Development Goal's target 3.2, which aims to end preventable deaths of children fewer than 5 years by 2030.

**Fast to reverse diabetes**

A type of fasting diet may reprogramme pancreas cells, promote the growth of new insulin-producing pancreatic cells and reduce symptoms of Type 1 and Type 2 diabetes, a study has shown.

In the study, led by researchers from the University of Southern California, mice were placed on fasting mimicking diet (FMD) for four days each week.

They showed remarkable reversal of diabetes.

The mice regained healthy insulin production, reduced insulin resistance.

They also demonstrated more stable levels of blood glucose — even in the later stages of the disease, the researchers said in the paper published in the journal *Cell*.

The genes normally active in the developing pancreas of embryonic/foetal mice are reactivated in diabetic adult mice when cycling FMD with normal diets.

This increases production of the protein neurogenin-3 (Ngn3) and, as a result, promotes the creation of new, healthy insulin-producing beta cells.

Researchers also examined pancreatic cell cultures from human donors and found that, in cells from



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Type 1 diabetes patients, nutrients mimicking fasting also increased expression of the Ngn3 protein and insulin production.

“These findings warrant a larger FDA trial on the use of the Fasting Mimicking Diet to treat diabetes patients,” said Valter Longo from the University of Southern California.

“People with diabetes could one day be treated with an FDA-approved Fasting Mimicking Diet for a few days each month, eat a normal diet for the rest of the month, and see positive results in their ability to control their blood sugar by producing normal levels of insulin and improving insulin function,” Longo added.

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## BIOTECHNOLOGY

### Goat with superfine wool cloned in China

The world's first cloned goat bearing superfine Cashmere wool was born in north China's Inner Mongolia Autonomous Region, local government said .

The goat will be raised in a base for animal husbandry research conducted by experts from agricultural universities in Inner Mongolia and southwest China's Yunnan Province, the Bayannur city government said.

The Cashmere fibre from the goat is less than 13.8 micrometres thick, much finer than the average of 15.8 micrometres of the famous Erlang Mountain goats in Inner Mongolia.

Cashmere wool is obtained from Cashmere goats and a few other types of goat.

### Mumbai researchers identify a protein critical for sperm motility

Revealing study Dr. Deepak Modi (left) and Vrushali Sagare-Patil found men with poor sperm motility had less of the protein in sperm.

Low levels of the heat shock protein 90 (HSP90) in sperm causes infertility in men

A Mumbai-based team of researchers has identified one more protein — heat shock protein 90 (HSP90) — found in human sperm that determines the ability of sperm to vigorously whip their tail and move or swim (motility) faster towards an egg to fertilise it.

The reduced ability of sperm to move towards the egg is one of the causes of infertility in men. The results were published recently in Journal of Assisted Reproduction and Genetics.

Studying groups of infertile men to find the causes of male infertility, the researchers observed that men with poor sperm motility have very low amounts of HSP90 in the sperm. In men with a greater percentage of highly motile sperm, the amount of the protein in the sperm was higher.

#### Two forms

The protein is present in two forms — HSP90 alpha and HSP90 beta. While the alpha form is present in the junction between the head and mid-piece of a sperm, the beta form is found in the tail. This is the first time the presence and abundance of the two forms of the protein in certain parts of the sperm has been reported.

"HSP90 beta is dominant in the tail. So we thought the motility is regulated by HSP90 beta isoform," says Dr. Deepak Modi at ICMR's National Institute for Research in Reproductive Health (NIRRH), Mumbai and the corresponding author of the paper.

At any time, sperm keep moving at a slow speed (basal motility) but in the presence of progesterone hormone, which is found in the female reproductive tract, the motility of sperm suddenly increases. It is this increased motility due to the hormone that helps sperm travel the long distance to reach the egg.

To ascertain whether the protein is needed for motility, the researchers used two drugs to inhibit the protein in vitro. "The basal motility of sperm was unaffected. But when we added progesterone hormone to sperm (which had the functions of HSP90 already inhibited by the drugs) we did not see sperm move faster and forward," Dr. Modi says.

#### Basal motility

"HSP90 protein is not the only one that is responsible for motility. So inhibition of this protein alone may not affect basal motility. Thus we got interested in looking at the effect of progesterone-induced motility," says Vrushali Sagare-Patil from NIRRH and the first author of the paper. While the basal motility is not dependent on HSP90, the protein is required to increase the motility of sperm when exposed to progesterone hormone. "If a man has low amounts of HSP90 protein in his sperm, the sperm will be unable to swim upwards to the tubes and fertilize the egg because it cannot feel the effects of progesterone. This will be a cause of infertility," Dr. Modi says.

"So the progesterone-driven motility requires additional machinery. One of the components is the HSP90 protein," he says.

#### Drug development

The information about the crucial role of HSP90 protein can help scientists to develop drugs to make sperm move faster and forward in the female reproductive tract in people who low sperm motility.

"At present there is no treatment for male infertility due to poor sperm motility caused by genetic causes," says Dr Indira Hinduja an IVF expert at Mumbai's Hinduja Hospital and a co-author of the paper. There is a possibility that this work might help the development of drugs that would help enhance sperm motility by restoring the functions of the protein.

Conversely, contraceptives can be developed to inhibit the protein so that sperm do not move faster and reach the egg to fertilise it even in the presence of the hormone.

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### A new 'nanodote' for all kinds of snakebite

Scientists have developed a 'nanodote'—a low-cost molecular gel — to counter snakebite in a manner far more effective than existing anti-venoms, an advance that may save thousands of lives in rural parts of India.

Worldwide, an estimated 4.5 million people are bitten annually.

Around 2.7 million suffer crippling injuries and more than 1,00,000 die, most of them farm workers and children in poor, rural parts of India and sub-Saharan Africa that have little healthcare.

"Current anti-venom is very specific to certain snake types. Ours seems to show broad-spectrum ability to stop cell destruction across species on many continents, and that is quite a big deal," said Jeffrey O'Brien of University of California, Irvine, U.S. Researchers synthesised a polymer nanogel material that binds to several key protein toxins, keeping them from bursting cell membranes and causing widespread destruction.

The human serum in the test tubes stayed clear, rather than turning scarlet from the venom's typical deadly rupture of red blood cells.

"The venom, a 'complex toxic cocktail' evolved over millennia to stay ahead of prey's own adaptive strategies, is absorbed onto the surface of nanoparticles in the new material and is permanently sequestered there, diverted from doing harm," said Ken Shea from the university. Thanks to the use of readily available, non-poisonous components, the "nanodote" has a long shelf life and costs less, researchers added.

### Study on fish reveals key to cure blindness

Scientists have discovered a chemical in the zebra fish brain that helps reveal how it regrows its retina, a finding that can potentially cure blindness in humans.

The findings showed that the levels of GABA (gamma aminobutyric acid), a neurotransmitter, best known for its role of calming nervous activity, drop when the unique self repair process kicks in.

Thus, blocking the chemical (GABA) could lead to new treatments for AMD (age-related macular degeneration), the most common cause of blindness and and retinitis pigmentosa.

The structure of the retinas (the light-sensing tissue at the back of the eye) of fish and mammals are basically the same and a reduction in GABA might be the trigger

for retinal regeneration, the researchers said.

"Our theory is that a drop in GABA concentration is the trigger for regeneration," said James Patton, Professor at Vanderbilt University, in Tennessee, US.

"If we are correct, then it might be possible to stimulate human retinas to repair themselves by treating them with a GABA inhibitor," Patton added.

In the study, the scientists injected drugs that kept GABA concentrations in the retinas of newly blinded fish at a high level,

They found that doing so suppressed the regeneration process.

After injecting an enzyme that lowers GABA levels in normal fish, they found that the Muller glia (retinal cells) began changing and proliferating, the first stage in the regeneration process.

The Muller glia (which in fish plays a key role in regeneration) is a special type of adult stem cell.

When regeneration is triggered in zebrafish, the Muller glia begins proliferating and then differentiating into replacements for the damaged nerve cells.

### Bio-inspired glue works under water

Scientists, drawing inspiration from substances shellfish create to stick to surfaces, have developed a super strong adhesive that works under water.

The bio-based glue performed better than 10 commercial adhesives when used to bond polished aluminium.

"Our current adhesives are terrible at wet bonding, yet marine biology solved this problem eons ago," said Jonathan Wilker, a professor at Purdue University in the US.

"Poly (catechol-styrene) is looking to be, possibly, one of the strongest underwater adhesives found to date," he said.

### Drug discovery for GPCR signaling made easy by IIT Kanpur

Discovering new drugs that bind to G Protein-Coupled Receptors (GPCRs), which are central to almost every physiological process in our body such as vision, taste, immune response and cardiovascular regulation, has become easier, thanks to research by a team led by Dr. Arun K. Shukla from the Department of Biological Sciences and Bioengineering, Indian Institute of Technology (IIT) Kanpur.

Nearly 50 per cent of prescription drugs currently available in the market for the treatment of blood pressure, heart failure, diabetes, obesity, cancer and many other human diseases target GPCR receptors. All these drugs bind to their respective receptors and either activate or



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stop their signalling. The work by Dr. Shukla's team has shown that the regulation of these receptors by these drugs can be simpler than generally thought — it can be mediated by engaging only the end of the receptor, which is called the tail of the receptor.

The results were published in the journal Nature Communications.

Receptors found on the cell surface receive signals and transmit them to inside the cells. A part of the receptor is embedded in the cell membrane and the other part protrudes outside the membrane and inside of the cell. The part of the receptor that protrudes outside the membrane changes its shape whenever a stimulus in the body binds to it. In response to this change in the outside part of the receptor, a corresponding change happens in the shape of the receptor that is positioned inside the cell. This change in the shape of the receptor positioned inside the cell allows it to bind to other proteins called effectors. These effectors cause specific effects in the cell, referred to as cell signalling, which leads to physiological changes in our body.

For example, a hormone in the blood called angiotensin binds to its receptor and activates the effector protein inside the cell causing an increase in blood pressure.

#### **The mechanism**

In people with normal blood pressure, a specific type of proteins called arrestins, which are effector proteins of GPCRs, bind to the receptor and pull it inside the cell (a process called receptor endocytosis). This prevents the angiotensin from binding to the receptor, thereby helping in controlling the blood pressure.

In the case of people with high blood pressure, the prescribed drug binds to the receptor. So even if angiotensin is present on the surface of the cell, it cannot bind to the receptor and start the signalling process that increases blood pressure.

#### **New approach**

"We were interested in understanding how different receptors interact with effectors and how the receptors recognise the stimuli," says Dr. Shukla. "We looked at the interaction of a receptor, which is a target for heart failure drugs, with its specific effectors, namely arrestins. When arrestins bind to the receptor, they arrest or disrupt the receptor signalling."

"The textbook understanding is that arrestins have to simultaneously bind at two sites — the tail of the receptor and the core of the receptor — for the drug to become effective in pulling the receptor inside the cell [to prevent the stimuli from binding to the receptor and start signal-

ling]," says Dr. Shukla.

"Through specific engineering of the receptor we basically disrupted one of the two binding sites, namely the core of receptor. We found that even without the second site, the arrestin was able to pull the receptor inside the cell by binding just to the tail of the receptor [which is the other binding site]," he says.

There is a key region in the core which the team genetically deleted thereby making the core of the receptor ineffective.

"Whenever researchers are designing a drug to stop GPCR signalling, they look for a drug that simultaneously triggers the binding of arrestins to both the sites in the receptor. Our work changes the way people will look at drug discovery for GPCR signalling," he says. "The drug has to trigger binding of arrestin to just at the tail of the receptor to arrest the signalling. Researchers can now design simple drugs to accomplish this."

### **Indian scientists' novel approach to diagnose retinal diseases**

Early diagnosis of certain eye diseases and studying the early progression of the diseases has now become possible, thanks to the work carried out by a team of researchers from three institutes — IISER, Kolkata, L.V. Prasad Eye Institute, Hyderabad, and BARC, Visakhapatnam. The researchers used the retinal data captured by a well-established imaging method in ophthalmology (optical coherence tomography or OCT) and applied an algorithm based on a statistical biomarker tool for early detection of diabetic macular edema. The results were published in the Journal of Biomedical Optics.

#### **Disease progression**

Early diagnosis of eye diseases and quantification of disease progression has been a challenge. For instance, the human retina has 10 layers and subtle morphological changes in these layers do not lead to a change in thickness that can be detected by OCT imaging. But OCT images do contain data on subtle refractive index variations and the researchers have successfully teased out this information to help diagnose eye diseases early and study the early progression of disease.

Biological tissues have complex geometrical patterns, which are called multifractals. "The OCT images are light intensity-based and so the multifractal information gets hidden," says Dr. Ashutosh Richhariya from Hyderabad's L.V. Prasad Eye Institute and one of the authors.

There is a change in the density of the constituents in each of the 10 layers and this gets manifested as differ-





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ent refractive indices. "As the disease progresses there is a change in the refractive index of the medium which gets recorded in the OCT images. And this data, which is hidden in the OCT images, can be extracted using multifractal detrended fluctuation analysis (MFDFA)," says Sabyasachi Mukhopadhyay from the Indian Institute of Science Education and Research (IISER), Kolkata, and one of the authors of the paper. Using the software, the researchers are able to find a peak at the junction between two layers from the refractive index data extracted from the OCT images. The thickness of a layer can be calculated by measuring the distance between two successive peaks. When the thickness of a layer becomes more as the disease progresses the distance between two successive peaks increases. "Finding different layers in a diseased condition was a challenge. But now it is doable," says Dr. Richhariya.

#### **Gauging depth**

"The two-dimensional OCT images have information on depth and lateral direction depth. We are interested in depth-related information. So we first unfolded the two-dimensional image into one-dimensional images and analysed these using multifractal detrended fluctuation analysis(MFDFA)," says Nandan Kumar Das from IISER, Kolkata, and the first author of the paper.

In the case of the retina, different layers are affected by different diseases. For instance, the photoreceptor layer is affected in the case of diabetic macular edema, while the top layer (retinal nerve fibre layer) is affected in the case of glaucoma. "So that's why it is important to know how the disease affects different layers," says Dr. Richhariya.

"Diabetic macular edema is well characterised and we know what changes to expect. So we used this disease for establishing our technique. We can use our approach for other eye diseases such as age-related macular degeneration (AMD) too," Dr. Richhariya says.

#### **A fully biocompatible cell-level motility engine**

In science fiction, we are familiar with instances of how tiny particles are dragged along by some artificial mechanism within the body – robotic cures, external control of the mind, drug delivery, the examples abound. Now a Chennai-based group - Ronojoy Adhikari from Institute of Mathematical Sciences and P. B. Sunil Kumar and Raj Kumar Manna from IIT Madras - has come up with a workable design for a system using which nanosized particles can be made to move through a viscous liquid like blood without the application of external energy. Unlike

in earlier schemes, the process is entirely biocompatible and does not involve the application of external magnetic fields etc. The research will appear in Journal of Chemical Physics.

The concept is that you have the cargo to be delivered inside a small micro-sized colloidal particle, which could also have a small piece of magnetite. This colloidal particle is attached to a string of active particles. These active particles by converting biochemical energy stored in ATP or carbohydrates into mechanical energy, make wavy or spiral movements that propel the colloidal particle through the viscous medium. Using a small magnetic field, of strengths that are safe for the human body, can be used to move this motility engine in the preferred direction.

"In this paper we show that it is possible to design synthetic filaments which can beat and work as motility engines for colloidal transport. We have provided a design for a fully biocompatible motility engine that can be put to a variety of uses," says Raj Kumar Manna, a research scholar at the physics department of IIT Madras, first author of the paper.

For tiny cell-sized objects, take even a blood cell moving within the plasma, simply diffusing through the medium is too slow and inefficient a process because of the viscosity of the fluid in question which drags the body backward. It would be like a person trying to swim through honey or molasses - they would need to spend much more energy than while swimming in water to traverse the same distance in a given time. In real life, micro-organisms and cells overcome this problem by what is called active transport – at the extra-cellular level, in some cases, this is achieved by having cilia or hairlike filaments that "beat" and move the surrounding fluid, thereby giving rise to motion. Two among myriad examples of bodies moving inside the body using active transport are sperms and the ciliary layer in the lung. Earlier work, which proved such things can happen outside of science fiction, showed that an inert sperm cell could be transported by an external motility engine to reach an egg cell within the uterus and fertilise it. But this involved the use of an external AC magnetic field to energise the vesicle and make it move towards the egg. The work by Manna et al on the other hand is completely biocompatible.

"The most important component of the work is the idea that stringing together active particles into a filament can generate enough power to transport a colloid. The challenging part was to incorporate the effect of fluid motion on the transport of the colloid. We use high performance computing facility to compute this hydrodynamic interac-

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tion,” says Prof. Sunil Kumar of IIT Madras. As a next step, “We want to include increasing degree of realism in our analysis: look at an environment that is more like blood, look at geometries which are more like branched capillaries, explore designs for greater energy efficiency and talk more closely with experimentalists,” says Prof. Adhikari of Institute of Mathematical Sciences. “People have been designing drugs on the computer for a long time. This is possibly the first instance where a realistic drug delivery engine has been designed on the computer,” he adds.

### **IIT Madras’ first step to cheaper cancer diagnostic alternative**

A team of researchers from the Indian Institute of Technology (IIT) Madras has developed a cheaper yet reliable alternative for diagnosing leukaemia and colorectal cancer. Like monoclonal antibodies which are currently used for cancer diagnostics, the fusion protein developed by the researchers has high specificity and sensitivity. The results were recently published in the journal *Molecular Diagnosis & Therapy*.

#### **Stem cell factors**

The researchers designed recombinant fusions of a ligand (stem cell factor) to a protein tag (SNAP-tag). The ligand binds to a particular receptor (c-kit) that is present in more than normal numbers on some cancer cells.

To quantitatively determine the amount of ligand that is bound to the receptors, the researchers used a commercially available fluorescent material (O6-Benzylguanine) that the protein tag binds to. The fluorescent material bound to the protein can be detected using a fluorescent microscope or flow cytometry.

“We report the first evidence that SNAP-tag could be used for outside the body (ex vivo) detection of enriched biological markers using SCF/c-kit as the target receptor system. The c-kit receptor is a pathological and diagnostic marker for a variety of cancers,” Dr. Swati Choudhary from the Department of Biotechnology, IIT Madras and the first author of the paper says in an email. “It is a proof-of-concept study.”

Using c-kit positive and negative cell lines, the researchers first tested the capacity of the protein tag to bind specifically to the c-kit receptors. “The specificity was comparable to the currently used monoclonal antibodies,” she says. “We then carried out a pilot study to test whether these proteins could be used for diagnostic purposes. We tested it on 16 peripheral blood samples from leukaemia patients and four colorectal biopsy specimens.”

“The sensitivity is as good as commercially available monoclonal antibodies. If sensitivity and specificity are high in large-scale studies, we could in future replace monoclonal antibody with SNAP-tag fusions to select ligands for diagnostic applications. It will also be much cheaper,” says Prof. Rama S. Verma from the Department of Biotechnology, IIT Madras, and one of the corresponding authors of the paper.

As a DAAD fellow, Dr. Choudhary carried out a part of the study at Fraunhofer Institute of Molecular Biology, Aachen, Germany.

#### **Long term potential**

“In the long term, these probes could potentially be used for diagnosing and staging of cancer and in the follow-up management of the disease,” Dr. Choudhary says. According to Prof. Verma, it would even be possible to find out early stages of cancer as the technique has high sensitivity.

Since c-kit receptor is overexpressed in other cancers such as gastrointestinal stromal tumours, small cell lung cancer, ovarian cancer, breast cancer and melanoma, the SNAP-labelled protein could theoretically be used for diagnosing these cancers.

“By replacing the stem cell factor with different ligands that targets other cancer cells, the technique can be used for identifying other cancers as well,” Dr. Choudhary says.

### **There is more to come in the CRISPR story**

The U.S. Patent and Trademark Office recently issued a key verdict in the battle over the intellectual property rights to the potentially lucrative gene-editing technique CRISPR–Cas9.

It ruled that the Broad Institute of Harvard and MIT in Cambridge, Massachusetts, could keep its patents on using CRISPR–Cas9 in eukaryotic cells. That was a blow to the University of California, Berkeley, which had filed its own patents and had hoped to have the Broad’s thrown out.

The fight goes back to 2012, when Jennifer Doudna at Berkeley; Emmanuelle Charpentier, then at the University of Vienna; and their colleagues outlined how CRISPR–Cas9 could be used to precisely cut isolated DNA. In 2013, Feng Zhang at the Broad and his colleagues — and other teams — showed how it could be adapted to edit DNA in eukaryotic cells such as plants, livestock and humans.

Berkeley filed for a patent earlier, but the USPTO granted the Broad’s patents first — and last week upheld them.



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There are high stakes involved in the ruling. The holder of key patents could make millions of dollars from CRISPR–Cas9’s applications in industry: Already, the technique has sped up genetic research, and scientists are using it to develop disease-resistant livestock and treatments for human diseases.

But the fight for patent rights to CRISPR technology is by no means over. Here are four reasons why.

**1. Berkeley can appeal the ruling.**

Berkeley has two months to appeal the USPTO’s ruling — and may well do so. A key question is how confident Berkeley feels that its own patents, once granted, would cover the most lucrative applications of gene editing in eukaryotic cells, such as generating new crops or human therapies.

The Broad’s victory centred on a key difference: that its patents specified how CRISPR could be adapted for use in eukaryotic cells and Berkeley’s did not. This is why the USPTO ruled that the Broad’s patents would not interfere with the granting of Berkeley’s, and so should be allowed to stand.

Berkeley’s team was quick to argue, in the wake of the decision, that its patent — if granted in its current state — would cover the use of CRISPR–Cas9 in any cell. That, the team says, would mean someone wanting to sell a product made using CRISPR–Cas9 in eukaryotic cells would need to license patents from both Berkeley and the Broad.

Yet the details of the USPTO’s ruling could weaken Berkeley’s chances of enforcing its patents in eukaryotic cells, patent scholars say. For example, much of the USPTO’s 50-page decision argues that the use of CRISPR–Cas9 in eukaryotic cells — described in the Broad patent — required additional invention beyond that described in the Berkeley patent application.

So Berkeley may feel that it must still appeal. And its intellectual property is already licensed to several companies that intend to deploy CRISPR–Cas9 in eukaryotic cells. Those companies will probably prefer not to have to pay for a license from the Broad as well.

**2. European patents are still up for grabs.**

Both teams have filed similar patents in Europe and are still battling for patent rights there.

And the decision in Europe may not necessarily follow the same path as the USPTO, notes Catherine Coombes, a patent lawyer at the intellectual property specialists HGF in York, England.

On the basis of European case law, the European Patent Office could choose to assess whether the discovery of

the general gene-editing system described in the Berkeley patent prompted “sufficient motivation” to try to make the leap to eukaryotic cells. If European judges find this to be the case, they could rule that the Berkeley patent covers eukaryotic applications of CRISPR–Cas9.

That could give Berkeley an edge that it lacked in the United States. “The fact that six groups got CRISPR–Cas9 to work in a eukaryotic environment within weeks of one another shows that in the field there was clear motivation to try,” says Coombes.

Even so, there is likely to be no quick resolution to the European patent battle either: Coombes estimates that it could drag out for another five years or more.

**3. Other parties are also claiming patent rights on CRISPR–Cas9.**

Attention has focused on the Berkeley–Broad battle because their patents are fairly broad and are seen as being crucial to most commercial applications of CRISPR–Cas9. But there are 763 patent families (groups of related patents) that claim Cas9, according to the consulting firm IPStudies near Lausanne, Switzerland. Of those, some claim patent rights to certain aspects of CRISPR–Cas9 gene editing. Over time, holders of those patents may try to assert those rights.

That may not happen until companies that use CRISPR–Cas9 start to make money from their products. At that point, someone who owns a related patent may sue for infringement and ask for royalties.

When the time comes, look for plenty of patent holders to come calling, says Jacob Sherkow, an intellectual property scholar at New York Law School in New York City. “Everybody and their third cousin twice removed is going to be claiming they have some inventorship interest in the Broad’s patent,” he says. “The Broad is going to be fighting those battles for years.”

**4. CRISPR technology is moving beyond what the patents cover.**

Researchers in academia and industry have been pushing CRISPR gene editing beyond the scope of the Broad and Berkeley patents.

Both patent families cover the use of CRISPR–Cas9, which relies on the Cas9 enzyme to cut DNA. But there are alternatives to Cas9 that provide other functions, and a way to sidestep the Berkeley–Broad patent fight.

One attractive alternative is Cpf1, an enzyme that may be simpler to use and more accurate than Cas9 in some cases. The Broad has already filed patents on applications of Cpf1 in gene editing, and has licensed them to the biotech company Editas Medicine in Cambridge (which





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also has licenses for some Broad patents on CRISPR–Cas9). In all, there are already 28 patent families that claim Cpf1, according to IPStudies, and not all of them are from the Broad.

Reports of other enzymes are trickling in. In December, researchers at Berkeley said that they had found two new Cas9 alternatives, CasX and CasY3. And some researchers may already be trying to patent unpublished alternatives — U.S. patent applications typically do not become public until 18 months after they are filed.

Sherkow likens the situation to the early days of PCR (the polymerase chain reaction), a technique used to amplify segments of DNA that quickly became a vital tool in molecular biology. Laboratories initially used just one enzyme, Taq1 polymerase, to carry out the protocol.

“Now if you go through the catalog, there’s almost an Amazon warehouse of polymerases that you can use depending on the particular reaction that you want to do,” he says.

People are tethering the commercialization aspect of CRISPR to this particular patent fight, Sherkow says. “That’s missing some of the broader picture.”

### **New clone of MRSA identified in Kerala aquatic environment**

A new clone of methicillin-resistant *Staphylococcus aureus* (MRSA), which is exclusive to Kochi, has been identified. The new clone, christened ‘t15669 MRSA’, is unique to seafood and the aquatic environment of Kerala. Scientists at the Central Institute of Fisheries Technology (CIFT), Kochi, identified the new clone while assessing the prevalence of MRSA in seafood and the environment. The study team comprised V. Murugadas, Toms C. Joseph, K.V. Lalitha and M. M. Prasad, all researchers at the Institute.

MRSA can lead to diseases ranging from milder form of skin infections, boils, furunculosis to life-threatening septicemia and bacteraemia from post-surgical contamination. The situation turns worse given their resistance to wide range of drugs, warned the researchers. However, as *S. aureus* causes disease by producing enterotoxin in the food, there is no immediate threat in consumption of seafood contaminated with MRSA.

“[The emergence of MRSA] has been identified as a health concern globally since the 1960s. However, little information is available on the prevalence of MRSA and its clonal characteristics in seafood and the aquatic environment,” the researchers say in a paper published in the *Journal of Food Protection*.

According to Dr. Murugadas, if the new clone, which is currently low in concentration in the Kochi geographical area, gets established and becomes widely prevalent then it can reach the seafood chain starting from the fish landing centres to the retail outlets very frequently.

The presence of MRSA in fish meant for human consumption is a potential health hazard for food handlers. The fingerprinting of MRSA can be useful for tracing local source and spread of MRSA isolates in a defined geographical area, they said.

#### **Accidental discovery**

According to C.N. Ravishankar, director of the CIFT, the scientists stumbled upon the new clone during a regular screening of fish samples, which the institute has been undertaking as part of its research and social responsibility activities. Fish samples collected from the landing centres as well as the markets are regularly screened at the CIFT labs to identify potential health hazards. Extensive research is being undertaken on MRSA.

### **Study on fish reveals key to cure blindness**

Scientists have discovered a chemical in the zebra fish brain that helps reveal how it regrows its retina, a finding that can potentially cure blindness in humans.

The findings showed that the levels of GABA (gamma aminobutyric acid), a neurotransmitter, best known for its role of calming nervous activity, drop when the unique self repair process kicks in.

Thus, blocking the chemical (GABA) could lead to new treatments for AMD (age-related macular degeneration), the most common cause of blindness and and retinitis pigmentosa.

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“If we are correct, then it might be possible to stimulate human retinas to repair themselves by treating them with a GABA inhibitor,” Patton added.

In the study, the scientists injected drugs that kept GABA concentrations in the retinas of newly blinded fish at a high level,

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After injecting an enzyme that lowers GABA levels in



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normal fish, they found that the Muller glia (retinal cells) began changing and proliferating, the first stage in the regeneration process.

The Muller glia (which in fish play a key role in regeneration) is a special type of adult stem cell.

When regeneration is triggered in zebrafish, the Muller glia begins proliferating and then differentiating into replacements for the damaged nerve cells.

### **CCMB researchers control weight and fat gain in animals**

The two chains of clusterin protein, which are normally expressed in several tissues and can be found in several body fluids, when present together tend to lower lipid levels but administration of one of its chains — alpha or beta — results in completely different outcomes. Cells treated with a recombinant beta chain tend to accumulate fat while cells treated with an alpha chain showed no increase in lipid accumulation. Rabbits administered with a recombinant beta chain showed nearly 40% increase in weight while animals given an alpha chain showed no such increase. The results were published in the journal *Scientific Reports*.

“Two chains of clusterin when present together tend to decrease body weight but one of the two chains (beta clusterin) increases body weight. This is quite unusual,” says Dr. Ch. Mohan Rao from the Centre for Cellular and Molecular Biology (CCMB), Hyderabad, and the corresponding author of the paper. “So the alpha chain should ideally be compensating for increase in body weight. But the alpha chain does not do that.”

#### **Only lean mass, no fat**

“While excess energy gets accumulated in the form of fat when beta chain was injected into rats, we did not see this in the case of alpha chain. One possibility is that the alpha chain helps in the metabolism of food in such a way that fat does not accumulate,” he says. “Dissected rats that were given alpha chain showed increased levels of lean mass.”

Apparently, there was no difference in the food intake between animals treated with alpha or beta chain. “It means that weight increase can happen even when there is no increase in food intake. It is the energy management by the body that is important. And alpha chain seems to modulate metabolism in such a way to promote energy expenditure and thus prevent fat accumulation,” he says. The effect of alpha and beta chains were tested on myoblast cells, fibroblast and cancer cells. The individual chains were injected into rabbits as well. “In my lab we

study the effect of small heat shock protein on health and disease. To raise antibody for clusterin we injected the chains separately into rabbits. One set of rabbits was gaining weight while the other did not. That’s when we investigated the reasons. The animal-house in-charge noticed the change in the animals,” recalls Dr. Rao.

#### **Rats too gained weight**

Though the effects of the two chains were seen in rabbits, the researchers turned to rats as more animals were required for investigating the effect of individual chains on animals.

“We could see fat accumulation in cells from day two onwards. We observed for 10 days and fat accumulation continued for all the 10 days; we could study cells continuously only for 10 days,” says Suvarsha Rao Matukumalli from CCMB and the first author of the paper. “In the case of animals injected with beta chain, fat accumulation continued for four-five months. The controls and animals given alpha chain did not show weight or fat gain.” When cells were administered both the chains simultaneously, the cells did not accumulate fat for two-three days but started thereafter. “Fat accumulation was not as much as when only the beta chain was given but fat accumulation nevertheless continued,” says Ms. Matukumalli. But the effect of both the chains in animals was quite different. “When we introduced both alpha and beta chains together in animals we did not see any weight gain. The animals were very much like the controls,” she says. “Only large-scale, in-depth studies can reveal if alpha chain prevents weight gain.”

### **Biofilm as a biological shield**

Bacteria form biofilms, a kind of matrix, during infection in plants and animals. The biofilm shields the bacteria from antibiotics and helps bacteria survive harsh conditions such as extreme temperature or stress. Now a study by Indian researchers has found the molecular signalling events that play a crucial role in biofilm formation in *Bacillus anthracis*, the causative agent of anthrax.

Till now, all attention has been on developing antibiotics that target disease-causing bacteria and not the biofilm itself.

One of the basic questions that scientists have been trying to answer is how and when bacteria decide to form biofilms. “One possibility is that bacteria has sensors on the surface which senses some signal and helps in biofilm formation,” says Andaleeb Sajid from the Institute of Genomics and Integrative Biology (IGIB), Delhi and one of the authors of the paper.

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"It was serendipity. Our lab was working on signalling in bacteria and we were studying PrkC and similar proteins. When PrkC protein is deleted, Bacillus bacteria are unable to form biofilm. So we started studying the mechanism by which PrkC protein controls biofilm formation," she says.

"Our hypothesis is that PrkC senses some signal and transmits it from outside to inside the cell. This signal goes to other proteins like GroEL. PrkC adds phosphate group (phosphorylate) to different proteins. The mystery to biofilm formation lies with one chaperone protein called GroEL. The addition of phosphate to this tiny machine initiates a course of events within bacterial cells leading to complex biofilm formation," Dr. Sajid says.

#### **GroEL protein's role**

The team found several proteins receive signals from PrkC protein. Using cutting edge genetics, molecular biology and proteomics techniques, they confirmed that GroEL was regulated by PrkC.

"From other unrelated bacteria, we already had a clue that GroEL has a role in biofilm formation. We looked at the molecular level and found six amino acid residues where phosphate was getting added to the GroEL protein. Through a series of steps, we ascertained how important phosphorylation was for proper functioning of GroEL," says Gunjan Arora from IGIB and the first author of the paper.

"We wanted to know if the bacterium has any other compensation mechanism to form biofilm in the absence of PrkC. So we made PrkC mutant bacteria to produce more of GroEL. The bacteria were able to form biofilm even in the absence of PrkC. This experiment helped us understand that PrkC is the influencer and GroEL is key to biofilm formation," Dr. Arora says.

Both PrkC and GroEL perform very important functions and are critical for bacterial ability to successfully infect humans. "We think GroEL-PrkC complex could be a target for developing new antibiotic that will be effective against many bacterial pathogens such as the ones that cause MRSA, TB and pneumonia. One strategy to tackle drug resistant bacteria will be to develop multi-drug regimen that combines traditional antibiotics with candidate drugs that can block bacterial signalling and prevent biofilm formation," Dr. Arora says.

### **Indians find a new bacterial target for drug development**

Indian researchers have found a new target that can potentially be used for developing new antibiotics that will

be effective against many bacteria. The new target is made of two proteins, which form a complex that is responsible for the formation of biofilm, that perform very important functions and are critical for bacterial ability to successfully infect humans. The results were published in the journal *Biofilms and Microbiomes*.

#### **Biofilm as a biological shield**

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### Indian teams among top 16 in green race

123 teams across Asia competed in designing a fuel efficient prototype vehicle

Three teams from engineering colleges in India ranked among the top 16 across Asia in terms of the energy efficiency of their prototype vehicles in a competition held in Singapore over the last weekend.

The Shell Eco-marathon, held in Singapore for the first time this year, was a competition in which 123 college teams across Asia competed in designing a fuel efficient prototype vehicle. The winners were those whose vehicles covered the most distance on a single unit of fuel — petrol, diesel, battery power, or hydrogen fuel cell. The best performance from an Indian team came from Team AVERERA from the Indian Institute of Technology, Banaras Hindu University. The team’s prototype vehicle covered 132 kilometres on one kilowatt-hour of energy.

#### Third attempt

“This year was our third attempt in this prestigious event,” Team AVERERA said following the event. “Our car got a staggering efficiency of 131.1 km/kwhr, and we stand as the most fuel efficient car of India and the 11th-most in Asia.” Team Kaizen from the Pandit Deendayal Petroleum University, also participating in the same category, clinched the 16th place with their vehicle covering 81 km on one kwhr.

The competition gave the teams a choice of three categories of fuel — gasoline (either petrol or diesel), battery electric, and hydrogen fuel cell. The competition was

further divided into two types of vehicles — prototypes, which are single-seater, three-wheeled vehicles, and urban concept vehicles, which are bigger, four-wheeled, and more road-worthy. While 12 Indian teams qualified to take part in the event in Singapore, only three managed to actually set a score on the track. The third Indian team to do so, DTU Supermileage from Delhi Technological University, took part in the urban concept category, running an internal combustion engine. Their vehicle ran 81 km on one litre of fuel, placing them on the 15th spot in their category.

Team Panthera from the Indira Gandhi Delhi Technical University for Women, the only all-girls team in the competition, could not take part in the competition, having failed to complete the mandatory technical inspection prior to being allowed to go on the track. However, they won the off-track award for ‘Perseverance and Spirit of the Event’. “Participating in Shell Eco-marathon Asia has helped prove to ourselves and others that machines and tools can equally belong in the hands of women,” Kashi-ka Tripathi from Team Panthera said. “We hope to inspire more girls back home and from around the region to be bold in pursuing careers in science and engineering.”

(The correspondent was in Singapore at the invitation of Shell)

### Porcupine inhibitors of use in regenerative medicine

In a new development, researchers have found out that a cancer drug could promote regeneration of heart tissue. An anticancer agent in development promotes regeneration of damaged heart muscle. This is an unexpected research finding that may help prevent congestive heart failure in the future.

The study findings were published online in Proceedings of the National Academy of Sciences.

Many parts of the body, such as blood cells and the lining of the gut, continuously renew themselves throughout a person’s life. Others, such as the heart, do not. Because of the heart’s inability to repair itself, damage caused by a heart attack causes permanent scarring that frequently results in serious weakening of the heart, known as heart failure.

For years, Dr. Lawrence Lum, Associate Professor of Cell Biology at UT Southwestern Medical Center, has worked to develop a cancer drug targeting Wnt signalling molecules. These molecules are crucial for tissue regeneration, but also frequently contribute to cancer. Essential to the production of Wnt proteins in humans is



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the porcupine (Porcn) enzyme, so-named because fruit fly embryos lacking this gene resemble a porcupine. In testing the porcupine inhibitor, the researchers noted a curiosity. “We saw many predictable adverse effects — in bone and hair, for example — but one surprise was the number of dividing cardiomyocytes (heart muscle cells) was slightly increased,” said Dr. Lum, senior author of the paper, and a member of UTSW’s Hamon Center for Regenerative Science and Medicine. “In addition to the intense interest in porcupine inhibitors as anticancer agents, this research shows that such agents could be useful in regenerative medicine.” Based on their initial results, the researchers induced heart attacks in mice and then treated them with a porcupine inhibitor. Their hearts’ ability to pump blood improved by nearly twofold compared to untreated animals.

### India to frame policy on synthetic biology

India is taking its first steps to evolve a policy on synthetic biology, an emerging science through which new life forms can potentially be made in labs and existing life forms, such as bacteria and other microbes, tweaked to produce specific proteins or chemically useful products. The Environment Ministry will be convening a group of experts on biodiversity and biotechnology, to assess synthetic biology work pursued in Indian labs, potential benefits and risks, and the implications of the trans-boundary movement of such life forms.

Synthetic biology in microbial systems holds promise for production of drugs, vaccines, fuel components and other chemicals. A popular example is the production of artemisinin, a powerful anti-malarial drug, in yeast, at a commercial level. Microorganisms have also been constructed to act as sensors that can detect a toxin in vitro (outside a living organism) or in vivo (inside a living organism).

There are assorted labs in India that work on synthetic biology.

Last December, officials from the Environment Ministry participated in the United Nations Biodiversity Conference of the Convention on Biological Diversity (CBD) at Cancun, Mexico, where about 8,000 delegates from 180 countries discussed matters related to biodiversity.

India, so far, has no policy on synthetic biology, and according to a presentation made at the venue, it has promised to “put in place a Synthetic Biology Team for articulating India’s view” at a forthcoming meeting.

“We do not have any obligations to put in place any policy immediately,” Amit Prasad, Additional Secretary, Ministry of Environment and Forests, told The Hindu.

### The mice helping make strides in gene therapies

University have successfully developed glow-in-the-dark mice using compounds that create proteins responsible for lighting up fireflies, an advance that may pave the way for new gene therapies. Timothy Blake, a post-doctoral fellow, refined compounds that carry instructions for assembling the protein that makes fireflies light up and delivered them into the cells of an anaesthetized mouse. Unlike traditional gene therapy that permanently alters the genetic makeup of the cell, the effect of the scientists’ technique is temporary.PTI

### There is more to come in the CRISPR story

Though the verdict is out on the patent case, there are many reasons why the fight to own this gene editing technology will continue

The U.S. Patent and Trademark Office recently issued a key verdict in the battle over the intellectual property rights to the potentially lucrative gene-editing technique CRISPR–Cas9.

It ruled that the Broad Institute of Harvard and MIT in Cambridge, Massachusetts, could keep its patents on using CRISPR–Cas9 in eukaryotic cells. That was a blow to the University of California, Berkeley, which had filed its own patents and had hoped to have the Broad’s thrown out.

The fight goes back to 2012, when Jennifer Doudna at Berkeley; Emmanuelle Charpentier, then at the University of Vienna; and their colleagues outlined how CRISPR–Cas9 could be used to precisely cut isolated DNA. In 2013, Feng Zhang at the Broad and his colleagues — and other teams — showed how it could be adapted to edit DNA in eukaryotic cells such as plants, livestock and humans.

Berkeley filed for a patent earlier, but the USPTO granted the Broad’s patents first — and last week upheld them. There are high stakes involved in the ruling. The holder of key patents could make millions of dollars from CRISPR–Cas9’s applications in industry: Already, the technique has sped up genetic research, and scientists are using it to develop disease-resistant livestock and treatments for human diseases.

But the fight for patent rights to CRISPR technology is by no means over. Here are four reasons why.

#### 1. Berkeley can appeal the ruling.

Berkeley has two months to appeal the USPTO’s ruling — and may well do so. A key question is how confident

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Berkeley feels that its own patents, once granted, would cover the most lucrative applications of gene editing in eukaryotic cells, such as generating new crops or human therapies.

The Broad's victory centred on a key difference: that its patents specified how CRISPR could be adapted for use in eukaryotic cells and Berkeley's did not. This is why the USPTO ruled that the Broad's patents would not interfere with the granting of Berkeley's, and so should be allowed to stand.

Berkeley's team was quick to argue, in the wake of the decision, that its patent — if granted in its current state — would cover the use of CRISPR–Cas9 in any cell. That, the team says, would mean someone wanting to sell a product made using CRISPR–Cas9 in eukaryotic cells would need to license patents from both Berkeley and the Broad.

Yet the details of the USPTO's ruling could weaken Berkeley's chances of enforcing its patents in eukaryotic cells, patent scholars say. For example, much of the USPTO's 50-page decision argues that the use of CRISPR–Cas9 in eukaryotic cells — described in the Broad patent — required additional invention beyond that described in the Berkeley patent application.

So Berkeley may feel that it must still appeal. And its intellectual property is already licensed to several companies that intend to deploy CRISPR–Cas9 in eukaryotic cells. Those companies will probably prefer not to have to pay for a license from the Broad as well.

### **2. European patents are still up for grabs.**

Both teams have filed similar patents in Europe and are still battling for patent rights there.

And the decision in Europe may not necessarily follow the same path as the USPTO, notes Catherine Coombes, a patent lawyer at the intellectual property specialists HGF in York, England.

On the basis of European case law, the European Patent Office could choose to assess whether the discovery of the general gene-editing system described in the Berkeley patent prompted "sufficient motivation" to try to make the leap to eukaryotic cells. If European judges find this to be the case, they could rule that the Berkeley patent covers eukaryotic applications of CRISPR–Cas9.

That could give Berkeley an edge that it lacked in the United States. "The fact that six groups got CRISPR–Cas9 to work in a eukaryotic environment within weeks of one another shows that in the field there was clear motivation to try," says Coombes.

Even so, there is likely to be no quick resolution to the

European patent battle either: Coombes estimates that it could drag out for another five years or more.

### **3. Other parties are also claiming patent rights on CRISPR–Cas9.**

Attention has focused on the Berkeley–Broad battle because their patents are fairly broad and are seen as being crucial to most commercial applications of CRISPR–Cas9. But there are 763 patent families (groups of related patents) that claim Cas9, according to the consulting firm IPStudies near Lausanne, Switzerland. Of those, some claim patent rights to certain aspects of CRISPR–Cas9 gene editing. Over time, holders of those patents may try to assert those rights.

That may not happen until companies that use CRISPR–Cas9 start to make money from their products. At that point, someone who owns a related patent may sue for infringement and ask for royalties.

When the time comes, look for plenty of patent holders to come calling, says Jacob Sherkow, an intellectual property scholar at New York Law School in New York City. "Everybody and their third cousin twice removed is going to be claiming they have some inventorship interest in the Broad's patent," he says. "The Broad is going to be fighting those battles for years."

### **4. CRISPR technology is moving beyond what the patents cover.**

Researchers in academia and industry have been pushing CRISPR gene editing beyond the scope of the Broad and Berkeley patents.

Both patent families cover the use of CRISPR–Cas9, which relies on the Cas9 enzyme to cut DNA. But there are alternatives to Cas9 that provide other functions, and a way to sidestep the Berkeley–Broad patent fight.

One attractive alternative is Cpf1, an enzyme that may be simpler to use and more accurate than Cas9 in some cases. The Broad has already filed patents on applications of Cpf1 in gene editing, and has licensed them to the biotech company Editas Medicine in Cambridge (which also has licenses for some Broad patents on CRISPR–Cas9). In all, there are already 28 patent families that claim Cpf1, according to IPStudies, and not all of them are from the Broad.

Reports of other enzymes are trickling in. In December, researchers at Berkeley said that they had found two new Cas9 alternatives, CasX and CasY3. And some researchers may already be trying to patent unpublished alternatives — U.S. patent applications typically do not become public until 18 months after they are filed.

Sherkow likens the situation to the early days of PCR





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(the polymerase chain reaction), a technique used to amplify segments of DNA that quickly became a vital tool in molecular biology. Laboratories initially used just one enzyme, Taq1 polymerase, to carry out the protocol.

“Now if you go through the catalog, there’s almost an Amazon warehouse of polymerases that you can use depending on the particular reaction that you want to do,” he says.

People are tethering the commercialization aspect of CRISPR to this particular patent fight, Sherkow says. “That’s missing some of the broader picture.”

### Organ-on-a-chip mimics the heart

Scientists have created a three-dimensional (3D) organ-on-a-chip that can mimic the heart’s amazing biomechanical properties and could help in studying cardiac diseases, screening and development of drugs.

“We created the I-Wire Heart-on-a-Chip so that we can understand why cardiac cells behave the way they do by asking the cells questions, instead of just watching them,” said Professor John Wikswo, from Vanderbilt University in the U.S.

#### Patching damage

“We believe it could prove invaluable in studying cardiac diseases, drug screening and drug development, and, in the future, in personalised medicine by identifying the cells taken from patients that can be used to patch damaged hearts effectively,” said Mr. Wikswo.

The device faithfully reproduces the response of cardiac cells to two different drugs that affect heart function in humans, initial experiments have demonstrated.

The unique aspect of the new device, which represents about two millionths of a human heart, is that it controls the mechanical force applied to cardiac cells.

This allows the researchers to reproduce the mechanical conditions of the living heart, which is continually stretching and contracting, in addition to its electrical and biochemical environment.

“Heart tissue, along with muscle, skeletal and vascular tissue, represents a special class of mechanically active biomaterials,” said Mr. Wikswo.

“Mechanical activity is an intrinsic property of these tissues so you can’t fully understand how they function and how they fail without taking this factor into account,” he said.

The I-Wire device consists of a thin thread of human cardiac cells 0.014 inches thick stretched between two perpendicular wire anchors.

#### Tension on fibre

The amount of tension on the fibre can be varied by moving the anchors in and out, and the tension is measured with a flexible probe that pushes against the side.

The fibre is supported by wires and a frame in an optically clear well that is filled with liquid medium like that which surrounds cardiac cells in the body.

The apparatus is mounted on the stage of a powerful optical microscope that records the fibre’s physical changes. The microscope also acts as a spectroscope that can provide information about the chemical changes taking place in the fibre. A floating microelectrode also measures the cells’ electrical activity.

According to the researchers, the I-Wire system can be used to characterise how cardiac cells respond to electrical stimulation and mechanical loads and can be implemented at low cost, small size and low fluid volumes, which make it suitable for screening drugs and toxins.

#### Growing cardiac cells

Unlike other designs, I-Wire allows the researchers to grow cardiac cells under controlled, time-varying tension similar to what they experience in living hearts.

The heart cells in the fibre align themselves in alternating dark and light bands, called sarcomeres, which are characteristic of human muscle tissue.

### A call for cheaper genetic screening

“We have our genes, and they are not going to change if we ignore them,” says Mary-Claire King, Professor of Genome Sciences at the University of Washington, who is best known for a path-breaking genetic discovery that has helped thousands of women make life-saving medical choices.

In 1990, she found that breast cancer — which kills more than 500,000 women worldwide every year — can, in fact, be inherited. Professor King identified the gene, BRCA1, which when mutant leads to a lifetime risk of breast cancer of 80% and ovarian cancer of 50%.

“I would like to convey to women that knowledge is power,” Professor King, a vocal advocate of genetic screening for breast and ovarian cancer risk for women over 30, told The Hindu here. She is in the city to deliver the first lecture in a four-city Cell Press-TNQ India Distinguished Lectureship Series. While tens of thousands of women in the U.S. now annually test for mutations in BRCA1 and related genes that increase breast cancer risk, the scenario is, of course, vastly different India. Breast cancer is the most common cancer among women in India, but



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genetic screening, at Rs. 25,000 to Rs. 60,000, is well beyond the means of most.

However, the technology now exists in many parts of the world to carry out screening much less expensively, and "this is really an opportunity for Indian scientists to undertake collaboratively the adoption here of the most up-to-date technologies," she said. "The intellectual capacity exists here. The scientific capacity exists here. But there hasn't been adequate exposure to the new technologies."

Professor King suggests that the best technologies first be applied to genetic testing for women who had been diagnosed with breast cancer or ovarian cancer. Though an opportunity to prevent the cancer had been missed, "we do have the opportunity to direct their treatment ... There are now particular treatments for breast and ovarian cancer that have been developed in consequence of the biological action of BRCA1 and BRCA2."

Another significant advantage of genetically screening a breast cancer patient is that it can provide vital information for the patient's daughters and sisters, because each of them has a 50-50 chance of having a mutation also and they can have especially stringent surveillance, Professor King said.

In the weeks following actor Angelina Jolie's article in the New York Times announcing her decision to have a double mastectomy as she found that she carried a BRCA1 mutation, there was a 64% spike in genetic screening.

"What happened with all this additional testing was that very few women proved to have the mutation; that's what we want, that's very good. Those that did [have the mutation] were then alerted to the possibilities for action, which range from increasing surveillance, to deciding to have a preventive removal of the ovaries and fallopian tubes after their childbearing is complete, to doing what Angelina Jolie did, which was to have a prophylactic mastectomy," Professor King said.

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## COMPUTER & IT

### Travel search engine KAYAK enters India

Global travel search engine KAYAK officially announced its entry into the Indian market, providing innovative travel tools to help people search, plan and manage their travel. Having pioneered the category globally, the company helps travellers get the information they need before they book and offers tools and features to assist them throughout their trip, KAYAK Director Southeast Asia and India Imbert Fung told PTI here. He said the website and mobile app search hundreds of travel sites at once so that travellers have the information they need to make the best decisions. KAYAK will help travellers to search and compare prices with ease, he said.

### As India goes digital, hacking targets multiply

Congress Vice President Rahul Gandhi's Twitter account was hacked and some expletives-laden tweets were posted. A day later, Congress Party's official Twitter account got breached.

"In either of the case I am certain there is more data in the hands of the hackers than just account access that might be released in due course of time," said Saket Modi, co-founder of cybersecurity start-up, Lucideus Tech.

At a time when an increasing number of Indians are going digital and doing transactions online, these hacking incidents expose the country's cybersecurity vulnerabilities. In India, there has been a surge of about 350 per cent of cybercrime cases registered under the Information Technology (IT) Act, 2000 from the year of 2011 to 2014, according to a joint study by The Associated Chambers of Commerce and Industry of India and consulting firm PricewaterhouseCoopers.

Mr. Modi of Lucideus said the hacking of the social media networks of Mr. Gandhi and Congress Party can be a potential backdoor malware being present on a computer system on which both the accounts might have been simultaneously accessed. He said this can also be a long persistent and targeted attack called 'spear phishing'. It is an e-mail spoofing fraud attempt that targets a specific organisation or individual. It seeks unauthorised access to confidential data.

### Spoofing banks

Researchers in India at cybersecurity company FireEye discovered phishing websites created by cybercriminals that spoof 26 Indian banks in order to steal personal information from customers. FireEye said that it has notified the Indian Computer Emergency Response Team.

"Criminals follow the money, and as more Indians embrace online banking, criminals followed them online," said Vishak Raman, Senior Director for India and SAARC at FireEye in a statement. He said as the digital economy grows, consumers should be aware of the risks that accompany the convenience. He said the ease of online payments opens new avenues for criminals to trick consumers into divulging their own sensitive banking information.

For instance, FireEye said that it has identified a new domain (csecurepay.com) registered in October this year, that appears to be an online payment gateway. But it is actually a phishing website that leads to the capturing of customer information from 26 banks operating in India. The company said that in this phishing attack, victims are asked to enter their account number, mobile number, email address, one-time password and other details.

Once the information is collected, the website displays a fake failed login message to the victim. The phishing site served fake logins from 26 banks, including large banks such as ICICI, HDFC and State Bank of India, according to FireEye.

Using the registration details of this domain, FireEye security researchers identified a second domain (nsecurepay.com) registered by the same attacker in August. This domain appears to be created to steal credit and debit card information including ICICI, Citibank, Visa and MasterCard and SBI debit card details. But it was observed to be producing errors at the time of discovery, according to FireEye.

### Google accounts

Experts are also seeing a shift in the strategy of hackers, who are now targeting mobile devices in order to obtain the sensitive information that is stored on them. Israeli cyber security firm Checkpoint said that its security researchers have revealed a new variant of Android malware, breaching the security of more than one million Google accounts.

The new malware campaign, named Gooligan, roots Android devices and steals email addresses and authentication tokens stored on them. With this information, attackers can access users' sensitive data from Gmail, Google Photos, Google Docs, Google Play and Google





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Drive, according to Check Point.

"This theft of over a million Google account details is very alarming and represents the next stage of cyber-attacks," said Michael Shaulov, Check Point's head of mobile products in a statement.

Check Point's Mobile Research Team first encountered Gooligan's code in the malicious SnapPea app last year. In August 2016, the malware reappeared with a new variant and has since infected at least 13,000 devices per day. About 40 per cent of these devices are located in Asia and about 12 per cent are in Europe.

#### **Infected app**

The infection begins when a user downloads and installs a Gooligan-infected app on a vulnerable Android device, or by clicking on malicious links in phishing attack text messages.

"As part of our ongoing efforts to protect users from the Ghost Push family of malware, we've taken numerous steps to protect our users and improve the security of the Android ecosystem overall," said Adrian Ludwig, Google's director of Android security. Google said it contacted affected users and revoked their tokens, removed apps associated with the Ghost Push family from Google Play, and added new protections to its verify Apps technology.

#### **Clean tech enthusiasts rework genetic codes for industrial use**

A decade ago, a group of biologists, venture capitalists and computer whizzes in the U.S. gathered under the name "clean tech." They hoped to overturn polluting industries with microorganisms cheerily recycling industrial chemicals through the miracle of reprogramming nature's genetic code.

The idea lost billions of dollars. Genes may indeed be programmable code, akin to computer software, but it turned out nature was more complex than first believed. Now, with less fanfare, a few clean-tech companies are aiming for a comeback. And the big idea has not changed much: Create cheap, safe and natural materials for fuel, cosmetics and other goods, much the way yeast ferments sugars into alcohol.

This time around, they believe they have better tools for editing genetic codes, measuring results and automating how chemicals are produced at a large scale. They have also set their sights lower, for now targeting just a few chemicals, not remaking how the world powers cars.

"This is like agile programming, but for biology," said Eric Steen, a co-founder of Lygos, a California start-up creating yeasts that make malonic acid, an ingredient in fragrances commonly derived from cyanide. "Evolution is

the most powerful algorithm ever, but you have to figure out how to stack it in your favour."

In computer-based agile programming, small teams reinforce positive signals about the way their code is working online. The Lygos version of this is to rapidly measure the performance of a novel yeast strain and quickly build on those results with gene-editing tools that are 100 times faster than when Mr. Steen was in graduate school, 15 years ago.

#### **Big data**

"It's a big data problem," he said, echoing one of the trendiest terms in computing. "There's 2,000 genes in this yeast, and each gene may use 300 amino acids. There's well over a million variants. Our first successful strain had just a tiny poop of malonic acid as a byproduct, but we seized on that, and kept building on it."

The company, which Mr. Steen and others spun out of the University of California, Berkeley, in 2011 with a \$150,000 grant from the U.S. Energy Department, recently secured \$13 million, on top of \$8 million it got from the government and a few private investors over the years.

It is natural to look at genetic engineering and think of H.G. Wells' Dr. Moreau, creating an island of miserable and dangerous freaks. At the same time, altering genes is what mankind has done for millennia, breeding wolves into Chihuahuas and cobs of loose-podded maize into big, uniform ears of corn.

What is different, and troubling to some, are the tools and the time scale. By directly altering the genetic make-up of plants and animals, the creations happen a thousand or more times as fast.

Lygos and other contemporary bio-based manufacturers benefit in particular from a tool called Crispr, which can snip into a sequence of DNA and insert desired features, like a propensity to create malonic acid. The process underlying Crispr was first observed in bacterial behaviour and then experimentally demonstrated in 2007, too late for the first bio-based chemical companies.

This capability, commonly spoken of as the genetic version of cutting and pasting in a word-processing program, bypasses the slow adjustments to a complex ecosystem that happen when nature brings forth a new species.

Nature's complexity is one reason clean tech fell short. Amyris, a clean-tech pioneer in Emeryville, California, first worked on anti-malarial drugs with backing from Bill Gates, then set out to make bio-fuels. Amyris found that organisms created in a California lab behaved differently in a Brazilian factory. The company spent \$250 million trying to figure out the problem while regular oil prices fell.

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"It turned out, we had to track every part of the process and automate as many things as possible," Peter Denardo, a company spokesman, said. "We've hired a lot more software and analytics people."

At least some big producers agree that these new tools and styles of genetic coding are reviving the clean-tech field.

"We have better tools, better computational biology," said Markus Pompejus, who runs a biotechnology program for BASF, the German chemical giant. "The whole thing is very real. It's already getting big."

### Centre to review IT Act to bolster cybersecurity

The government is mulling a review of the more than 15-year-old Information Technology (IT), Act to strengthen cybersecurity infrastructure, following the push for digital payments post-demonetisation.

"The IT Act came out in 2000. Since then, it has by and large served us well. Now, as we move towards a digital economy, we are reviewing if there is a need to re-look at the IT Act architecture to make it more of a deterrent for cyber criminals," Minister for Electronics and IT Ravi Shankar Prasad said.

A "closed group", under IT Secretary Aruna Sundarajan, has been set up to look into various aspects of the Act in line with the changing times.

The Ministry of Electronics and IT (MeitY), which will soon issue advisories to all digital payment agencies including banks and e-wallets providers "to harden security walls", has also set up a separate 'digital payments' division under Indian Computer Emergency Response Team (CERT-In) — its cyber security arm — to monitor and strengthen cashless transactions. "All digital payments agencies have been asked to report to CERT-In any unusual activity that they see on their platforms," Mr. Prasad said. The division was set up after the November 8 announcement withdraws old Rs.500 and Rs.1000 notes from circulation.

The Minister said, "We are taking several measures to ensure a resilient system. We will audit IT infra of NPCI... have formed crack teams at CERT-In for immediate response ... There are CIOs who have been appointed in every ministry and govt department... We are undertaking massive program to create awareness among administrators, judges etc."

To strengthen cyber security, the IT ministry had recently approved 26 new posts in CERT-In and five State CERTs. The Minister also met senior representatives of the RBI

as well as public and private sector banks, and NPCI. While asking banks to incentivise digital payments and transactions, Mr. Prasad said, to address concerns of cyber security, the IT ministry would soon conduct a security drill both for the banks and NPCI.

### New Wi-Fi system to offer super-fast connectivity

The wireless network is based on harmless infrared rays. Scientists have developed a new wireless Internet based on infrared rays that is reportedly 100 times faster than existing Wi-Fi networks.

The wireless network developed by researchers at Eindhoven University of Technology in The Netherlands not only has a huge capacity — more than 40 Gigabits per second (Gbit/s) — but does away with the need to share Wi-Fi as every device gets its own ray of light.

The wireless data comes from a few central 'light antennas', which can be mounted on the ceiling, that are able to precisely direct the rays of light supplied by an optical fibre.

The antennas contain a pair of gratings that radiate light rays of different wavelengths at different angles ('passive diffraction gratings').

Changing the light wavelengths also changes the direction of the ray of light. A safe infrared wavelength is used that does not reach the retina in the eye.

If a user is walking about and a smartphone or tablet moves out of the light antenna's direction, then another light antenna takes over, researchers said.

### Tracks precise location

The network tracks the precise location of every wireless device using its radio signal transmitted in the return direction, they said.

Different devices are assigned different wavelengths by the same light antenna and so do not have to share capacity.

Current Wi-Fi uses radio signals with a frequency of 2.5 or five gigahertz. The new system uses infrared light with wavelengths of 1,500 nanometres and higher. Researchers managed to achieve a speed of 42.8 Gbit/s over a distance of 2.5 metres. The team said that even with the best Wi-Fi systems currently available, users would not get more than 300 Megabit/s in total, which is some hundred times less than the speed per ray of light achieved by the new system.

The system has so far used the light rays only to download; uploads are still done using radio signals since in most applications much less capacity is needed for up-



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loading.

### Google to bring artificial intelligence into daily life

Artificial intelligence has been the secret sauce for some of the biggest technology companies. But technology giant Alphabet Inc.'s Google is betting big on 'democratising' artificial intelligence and machine learning and making them available to everyone — users, developers and enterprises.

From detecting and managing deadly diseases, reducing accident risks to discovering financial fraud, Google said that it aimed to improve the quality of life by lowering entry barriers to using these technologies. These technologies would also add a lot of value to self-driving cars, Google Photos' search capabilities and even Snapchat filters that convert the images of users into animated pictures.

"Google's cloud platform already delivers customer applications to over a billion users every day," said Fei-Fei Li, chief scientist of AI and machine learning at Google Cloud. "Now if you can only imagine, combining the massive reach of this platform with the power of AI and making it available to everyone."



### No programming

AI aims to build machines that can simulate human intelligence processes, while Stanford University describes machine learning as "the science of getting computers to act without being explicitly programmed."

At the Google Cloud Next conference in San Francisco this month, Ms. Li announced the availability of cloud 'Video Intelligence API' to the developers. The technology was demonstrated on stage while playing a video. The API was not only able to find a dog in the video but also identify it as a dachshund. In another demo, a simple search for "beach" threw up videos which had beach clips inside them.

Google is also aiming to use AI and machine learning to bring healthcare to the underserved population. It uses the power of computer-based intelligence to detect

breast cancer. It does this by teaching the algorithm to search for cell patterns in the tissue slides; the same way doctors review slides.

The Google Research Blog said this method had reached 89% accuracy, exceeding the 73% score for a pathologist with no time constraint.

Google Research said that pathologists are responsible for reviewing all the biological tissues visible on a slide. However, there can be many slides per patient. And each slide consists over 10 gigapixels when digitised at 40 times magnification.

Google feeds large amounts of information to its system and then teaches it to search for patterns using 'deep learning', a technique to implement machine learning. The team detected that the computer could understand the nature of pathology through analysing billions of pictures provided by Netherlands-based Radboud University Medical Center. Its algorithms were optimised for localisation of breast cancer that had spread to lymph nodes adjacent to the breast.

The team had earlier applied deep learning to interpret signs of diabetic retinopathy in retinal photographs. The condition is the fastest-growing cause of blindness, with close to 415 million diabetic patients at risk worldwide.

### An 'exoskeleton robot' to help the disabled

A China-made wearable robot, which can help disabled people walk, is expected to enter the market in one to two years, the developer has said.

The Fourier X1, developed by Chinese technology start-up Fourier Intelligence, was unveiled in Shanghai earlier this month, according to Xinhua news agency.

Gu Jie, CEO of Fourier, said the Fourier X1 weighed 20 kg and applied industrial design into the exoskeleton. It can assist with walking for people who have had a stroke or spinal cord injuries.

He said the company aimed to make the robot more affordable than foreign models such as Israel-made Re-Walk and Japanese-made Cyberdyne currently on the market.

Prices of the Fourier X1 robots are expected to be a third cheaper than similar foreign models, which are sold between 600,000 yuan (\$87,000) and 1 million yuan (\$1,450,000) each. Mr. Gu said the company was working to test and improve the robot's various functions such as sitting, standing, walking and climbing stairs.

The Fourier X1 has four motors, two for the hips and two for the knees, as well as four batteries inside that enable





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it to work for seven hours.

China has 80 million disabled people, many of them unable to walk. The global market for walk-assisting exoskeleton robots is estimated to exceed \$1.8 billion by 2020.

### New AI system can see like humans

A new computational model performs at human levels when subjected to standard intelligence test, making artificial intelligence (AI) system at par with human understanding capabilities.

Researchers from Northwestern University built the new computational model on CogSketch, an artificial intelligence platform, that has the ability to solve visual problems and understand sketches in order to give immediate and interactive feedback.

"The model performs in the 75th percentile for American adults, making it better than average," said Ken Forbus of Northwestern University. Researchers noted that developing artificial intelligence systems that have this ability not only provides new evidence for the importance of symbolic representations and analogy in visual reasoning, but it could potentially shrink the gap between computer and human cognition.

"Most artificial intelligence research today concerning vision focuses on recognition or labelling what is in a scene rather than reasoning about it," Forbus noted.

The key to higher-order cognition is the ability to use and understand sophisticated relational representations.

"Relational representations connect entities and ideas such as 'the clock is above the door' or 'pressure differences cause water to flow' These types of comparisons are crucial for making and understanding analogies, which humans use to solve problems, weigh moral dilemmas, and describe the world around them," the study published in journal Psychological Review, noted.

### Darknet robust for lack of 'rich clubs'

Recent research analysing the structure of the Darknet in comparison with the Internet reveals that the former is, in fact, more robust against factors such as security breaches or systemic instabilities than the Internet. The analysis shows this is because of its peculiar topology that is different from that of the Internet. The Darknet's lack of a "rich club"-like core of highly connected nodes is one aspect that renders it robust against random crashes, targeted attacks and also cascading effects of failures of core nodes. This research is to be published in Physical Review E. "Internet is highly centralized around hubs, [has] highly connected nodes which are very intercon-

nected each other. The Darknet is highly decentralized: we did not find a core of hubs. This [requires] much more effort to dismantle the network," says Manlio De Domenico, an author of the paper, in an email.

### The alter ego

The Internet and the Darknet have formed the subject of much research, especially regarding the higher robustness of the latter network. First created in the early 1990s by the US agencies – Defense Advanced Research Projects Agency (DARPA) and the Office of Naval Research – the Darknet is both resistant to eavesdropping and traffic analysis.

The Internet that we all know so well and can access using search engines like Google or Bing constitutes just a small fraction of the total of overlay networks; there is also the Darknet, the Internet's alter ego, which consists of the Web's non-indexed parts that cannot be accessed by search engines. What is more, this Darknet can be accessed only using onion routers like Tor or The Freenet Project– which are special browsers that ensure anonymity of the surfer as well as the service provider. While this is used by defence establishments for passing on sensitive and classified information, it is also, for instance, used by journalists who require utmost secrecy. Certainly it has a sinister side, with criminals also making full use of this technology.

From a network point of view, the structure of the Darknet is very different from that of the Internet. While in the Internet nodes that are central tend to connect more with each other, forming a "rich club" it is not the case in the Darknet. The centralised structure of the Internet makes it more vulnerable to attacks, because by hitting at the central nodes, one can destabilize the entire system. This can't be done with the Darknet which has a decentralised structure.

### Dynamical instability

The Internet crashed for the first time in 1980 when it hosted thousands of users. The crash was due to a cascading effect of a mistake that originated in one router and not due to an attack on a central node.

This sort of cascade can propagate more easily through a network with rich club nodes, than a decentralised Darknet type structure.

Explaining the strength of the Darknet, Dr De Domenico says, "The fact that its network is highly decentralized makes [it] more efficient: if a node crashes, the load is redistributed almost equally among other nodes, with no super-nodes overloaded. This is true at the beginning of the process, and it is not the case with the Internet



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(where if a hub fails, it is likely to redistribute its load to other hubs thus overloading them).”

The researchers also predict that the Darknet is undergoing a transition from decentralised to centralised structure, based on observations over a span of a few years. This remains, however, to be checked by future studies.

### **Flying high in virtual world**

If the ‘reality’ of a relatively lacklustre air show and plane display had seen disappointment among the swelling crowds at Aero India here, it was the ‘virtual’ world that came to their rescue.

While there is little doubt that air shows and display of planes were toned down compared with the last edition, the exhibition halls used cutting-edge technology to bring visitors one step closer to the cherished metal birds.

The use of virtual reality (VR), 360 degree immersible software, simulators, and mock-up displays was omnipresent in the exhibits, allowing visitors to get into the cockpits of the indigenous fighter Tejas, Lockheed Martin’s F-16, the civilian aircraft Saras, and the Swedish fighter Gripen.

The most popular simulator — as seen with the lengthy queues — was that of the virtual ‘experiences’ set up for the light combat aircraft, Tejas, which had also dominated the displays and air shows.

### **Learning about design**

Aeronautical Development Agency (ADA) allowed visitors to try on immersive virtual reality through head mounts where visitors can see in 360 degrees how the LCA is designed in the computer (a rough 3D sketch of the major mechanical components) and also how the finished product looks. “This is a good way to show visitors how the planning occurs before even a prototype is made. Through motion tracking and haptic force feedback system (which simulates a mechanic’s hand), we can even test if replacing a nut or bolt will become difficult,” said Shiek Nagur from the ADA.

Swedish defence company Saab, which manufactures the fighter jet Gripen, allows visitors to get into the cockpit through their VR headset.

Nearby, a cockpit mock-up of Tejas allows visitors to sit on the pilot’s seat and attempt to take off and fly in the virtual world. Similarly, Lockheed Martin provided a few visitors the opportunity to take F-16, a single-engine supersonic multi-role fighter aircraft, for a spin through their cockpit simulator; while HAL too has put up the simulator for the advanced Hawk, allowing that privy to experience what it is like being a Surya Kiran trainer.

For pilots, the simulator for Saras, which will be revived

after nearly a decade by the National Aerospace Laboratories, provides an opportunity to fly out of HAL Airport, circle around the airport and return.

### **India building a supercomputer juggernaut**

Come June, India will likely unveil its most powerful supercomputer. If its processors operate at the full capacity of 10 petaflops (1 followed by 15 zeroes of floating point operations per second), a clock speed a million times faster than the fastest consumer laptops, it could earn a place among the world’s top 10 fastest supercomputers. Though India has built or hosted supercomputers since the 1990s, it held a ‘top 10’ spot only once, in 2007, thanks to the EKA built by the Computational Research Laboratories, which is part of the Tata group. This position was lost, though several ultra-fast machines exist in Indian academic institutions: they feature in the 100s or 200s in global rankings.

The as-yet-unnamed machine will be jointly hosted at the Indian Institute of Tropical Meteorology, Pune and the National Centre for Medium Range Weather Forecasting at Noida in Uttar Pradesh.

For the first time, colleges and other research institutions can log in and harness its power to address problems, ranging from weather modelling to understanding how proteins fold. “The tender [to select the company that will build the machine] is ready and we hope to have it [the computer] by June” Madhavan Rajeevan, Secretary, Ministry of Earth Sciences, told The Hindu.

### **Rs. 400 crore sanctioned**

The government has sanctioned Rs. 400 crore for the project this year. Most of the machine’s computing power will help in monsoon forecasting, using a dynamical model. This requires simulating the weather for a given month — say March — and letting a custom-built model calculate how the actual weather will play out over June, July, August and September.

The processing speed of supercomputers is only one of the factors that determine its worth, with power usage and arrangement of processors, being other key metrics that determine the worth of a system.

Top500, the global authority tracking the fastest 500 computers, said in its latest report that China and the U.S. were “pacing each other for supercomputing supremacy.”

### **Artificial intelligence tool combats trolls**

Google has said it will begin offering media groups an artificial intelligence tool designed to stamp out incendiary



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comments on their websites.

The programming tool, called Perspective, aims to assist editors trying to moderate discussions by filtering out abusive “troll” comments, which Google says can stymie smart online discussions.

“Seventy-two percent of American internet users have witnessed harassment online and nearly half have personally experienced it,” said Jared Cohen, president of Google’s Jigsaw technology incubator.

“Almost a third self-censor what they post online for fear of retribution,” he added in a blog post titled “When computers learn to swear”.

Perspective is an application programming interface (API), or set of methods for facilitating communication between systems and devices, that uses machine learning to rate how comments might be regarded by other users. The system, which will be provided free to media groups including social media sites, is being tested by The Economist, The Guardian, The New York Times and Wikipedia.

Many news organisations have closed down their comments sections for lack of sufficient human resources to monitor the postings.

Google has been testing the tool since September with The New York Times, which wanted to find a way to maintain a “civil and thoughtful” atmosphere in reader comment sections.

Perspective’s initial task is to spot toxic language in English, but Cohen said the goal was to build tools for other languages, and which could identify when comments are “unsubstantial or off-topic”.

Twitter said earlier this month that it too would start rooting out hateful messages, which are often anonymous, by identifying the authors and prohibiting them from opening new accounts, or hiding them from internet searches.

Last year, Google, Twitter, Facebook and Microsoft signed a “code of good conduct” with the European Commission, pledging to examine most abusive content signalled by users within 24 hours.

### Darknet robust for lack of ‘rich clubs’

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### The alter ego

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The researchers also predict that the Darknet is undergoing a transition from decentralised to centralised structure, based on observations over a span of a few years. This remains, however, to be checked by future studies.

### First robot table tennis tutor sets Guinness record

The world's first robot table tennis tutor in Japan has set a new Guinness World Record for its uncanny ability of being able to play the game better than most humans.

FORPHEUS (Future Omron Robotics Technology for Exploring Possibility of Harmonised Automation with Sinic Theoretics) has officially been given the Guinness title for its unique technological intelligence and educational capabilities. According to the project's lead developer Taku Oya, from Omron Corporation, the goal of FORPHEUS is to harmonise humans and robots, by way of teaching the game of table tennis to human players. The machine is easily able to act as a coach, thanks to cutting-edge vision and motion sensors it can use to gauge movement during a match.

FORPHEUS also features an array of cameras that are situated above the ping pong table that monitors the position of the ball at an impressive rate of 80 times per second.

This functionality also allows the robot to show its human student to see a projected image as to where the return ball will land so that they may improve their skills. One of the most difficult aspects of the project was determining the algorithms needed for artificial intelligence that would help FORPHEUS determine how well human participants play the game.

But, once the perfect computation was established, it was only a matter of designing a speed-sensing component, which calculates opponents' ball at one thousand times per second, before the robot was a viable tutor. FORPHEUS encourages players to try their best by showing supportive messages along the LED screen situated on the table's net.

"Now, it is a human who teaches a robot how to behave or teach, but in the next 20 years, it may be possible that a robot teaches a robot or a robot develops a robot," said Mr Oya.

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## DEFENCE

### Defense Deal with India Will Harm Bangladesh's Sovereignty

A proposed defense deal likely to be signed with India during Prime Minister Sheikh Hasina's impending Delhi visit, will threaten the sovereignty of Bangladesh, the BNP has claimed.

BNP Standing Committee member Amir Khasru Mahmud Chowdhury said on Monday that he felt such a deal between the neighbors was unnecessary at the moment.

"It will only threaten the sovereignty of Bangladesh," he told a discussion in Dhaka, without elaborating.

Sheikh Hasina is scheduled to visit India from April 7 to 10. Either a defense deal or memorandum of understanding is expected to be signed between Bangladesh and India during this time.

Khasru questioned Dhaka and Delhi's motives.

"Bangladesh and India have many pending bilateral issues including the Teesta water sharing treaty. Why are they rushing the defence deal without prioritizing other long-standing issues?" he asked.

Source: [indiandefencenews](http://indiandefencenews.com)

### First joint military drill between China-Nepal

Nepal and China will hold their first ever joint military exercise in early February that will focus on counter terrorism operations and disaster management. According to the Chinese Defence Ministry Spokesperson Yang Yujun was that China and Nepal had been in "initial communication" on holding the military exercise, and that the details would be announced later.

The Nepal Army has also confirmed the joint military drills with China, saying the two sides have decided to hold the exercise in the northern region of Nepal in the second week of February, the Kathmandu Post reported.

Although Nepal has been holding joint military exercises with other countries including India and the United States, this is the first time Nepali military would be holding such an exercise with China.

"Nepal and China have been exchanging military delegations, visits and courses but such kind of drill is taking place for the first time," NA Spokesperson Brigadier Tara Bahadur Karki was quoted as saying by the daily.

"We have nothing much to add to the government's an-

nouncement about the proposed exercise," he said.

The proposed drill named 'Pratihar-I', will be focused on counter terrorism and disaster management, according to the Defence Ministry.

While neither side has yet ascertained the number of troops for the drills, senior NA officials have indicated that it would be "in a small scale even smaller than a platoon level."

The move may raise eyebrows in India over the intent of such an exercise, the daily said.

A Nepalese Defence Ministry official, however, played down the joint drill, saying it does not carry importance in terms of strategic implications.

The new development is seen as China's growing influence in the Himalayan nation since the deterioration of relations between Nepal and India due to the protracted border blockade last year.

### India is world's largest arms importer: SIPRI

India was the world's largest importer of major arms in the last five years and its overseas procurement was far greater than that of China and Pakistan, a Stockholm-based think-tank has said.

As per latest report of the Stockholm International Peace Research Institute (SIPRI), India accounted for 13 per cent of the total global arms import between 2012 -16 which is highest among all the countries.

The report on Tuesday said while China was increasingly able to substitute arms imports with indigenous products, India remained dependent on weapons technology from Russia, the US, Europe, Israel and South Korea.

"India was the world's largest importer of major arms in 2012-16, accounting for 13 per cent of the global total," the leading think-tank said.

It said India increased its arms imports by 43 per cent between 2007-11 and 2012-16 and in the last four years its global procurement was far greater than those of its regional rivals China and Pakistan.

In the last five years, the report found that trade of major weapons has increased to its highest volume since the Cold War, triggered mainly by sudden spurt in demand from Middle East and Asia.

Saudi Arabia was the second largest arms importer in 2012-16, with an increase of 212 per cent compared with 2007-11. Arms imports by Qatar went up by 245 per cent. According to the report, Russia accounted for a 23 per cent share of global exports in the period 2012-16 and 70



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per cent of its arms exports went to India, Vietnam, China and Algeria.

The US was the top arms exporter in 2012-16 with a one-third share of global arms exports and its supplies rose by 21 per cent compared with 2007-11. Almost half of its arms exports went to the Middle East, said the report.

The report said China's share of global arms exports rose from 3.8 to 6.2 per cent between 2007-11 and 2012-16.

"It is now firmly a top-tier supplier, like France and Germany which accounted for 6 per cent and 5.6 per cent, respectively," said the think-tank.

"The USA supplies major arms to at least 100 countries around the world significantly more than any other supplier state," said Dr Aude Fleurant, Director of the SIPRI Arms and Military Expenditure Programme.

The report said arms imports by states in Asia and Oceania accounted for 43 per cent of global imports between 2012 and 2016 which was an increase of 7.7 per cent compared to 2007-11 period.

"The volume transfers of major weapons has grown continuously since 2004 and increased by 8.4 per cent between 2007-11 and 2012-16. Notably, transfers of major weapons in 2012-16 reached their highest volume for any five-year period since the end of the cold war," the independent institute said in a statement.

It said, between 2007-11 and 2012-16, arms imports by states in the Middle East rose by 86 per cent and accounted for 29 per cent of global imports in 2012-16.

"Over the past five years, most states in the Middle East have turned primarily to the USA and Europe in their accelerated pursuit of advanced military capabilities," said Pieter Wezeman, Senior Researcher with the SIPRI Arms and Military Expenditure Programme.

He said despite low oil prices, countries in the region continued to order more weapons in 2016, perceiving them as crucial tools for dealing with conflicts and regional tensions.

Imports by states in Europe significantly decreased by 36 per cent between 2007-11 and 2012-16.

### **Indigenous basic trainer aircraft's certification likely in 2018**

The state-run Hindustan Aeronautics Ltd has said that India's indigenous basic trainer aircraft, Hindustan Turbo-prop Trainer-40 (HTT-40), is likely to be certified in 2018. HAL Chairman and Managing Director T Suvarna Raju on February 17 flew in the HTT-40 and Hawk-i aircraft at Aero India 2017 being held at the Air Force Station in Yelahanka in Bengaluru.

"We are trying to take a managerial decision in the middle of this year and by next year complete the certification process," Raju told reporters.

"It may take the middle of this year, depending on the spin and stall characteristics of HTT-40, we may launch limited series production by the end of this year," he said. HTT-40 will replace Hindustan Piston Trainer (HPT)-32 'Deepak' that was being used by IAF for primary training. The aircraft would be used for basic flight training, aerobatics, instrument flying and close-formation flights, whereas its secondary role would include navigation and night flying.

Developed with internal funding of HAL, HTT-40's inaugural flight of PT-1 was carried out on June 17, 2016. Two more prototypes are being manufactured to speed up flight trials and development process.

Stating that HAL expects an order of 106 aircraft, Raju said there are also export enquiries for the basic trainer.

"We do have enquiries on basic trainer and basic trainer with minimum weapon onto it, an integration which will follow after certification or once the basic characteristics are positioned....," he said.

After flying in the first indigenously upgraded Hawk Mk132, named Hawk-i, piloted by Wg Cdr Pratyush Awasti, Raju described it as a "lifetime" experience and said it gave him an opportunity to practically see and feel the upgraded aircraft.

The 100th Hawk aircraft produced at HAL is an upgraded one. It is equipped with indigenous Mission Computer in dual redundant configuration, Embedded Virtual Training System, Softnet Radio and Cockpit Human Machine Interface (HMI).

To a question on further upgradation process, Raju said "Now what we have done it is we have matured it an demonstrated to customer, the customer is already with us... we will take their comments and if anything is required in their opinion they will interact with us, and we will try and incorporate."

"Once we do this we will take it back to the Indian Air Force. About 100 aeroplanes are there, they will be upgrades in a scheduled manner," he said.





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## AGRICULTURE

### Tweaking photosynthesis for a better crop yield

We depend on plants for much of our food, clothing and shelter. Plants depend on the material in the soil and earth below, water, air and sunshine for their growth. Sunlight is thus an essential raw material for the growth of plants. Using sunlight, water and carbon dioxide present in air, plants synthesis what is needed for much of their own metabolic needs (and thus our needs). This process, known as photosynthesis, is carried out largely by the leaves (and similar appendages) in plants. Humans and many animals are dependent on the efficiency with which plants photosynthesis, grow and multiply.

As human population increases, we would need more of crops in order to cater to the global demands for food. It thus becomes important to study ways in which plant productivity can be increased. One way of approaching this is to find ways in which photosynthesis can be improved. An international team of researchers, led by Dr Stephen P. Long of the University of Illinois and Dr Krishna K. Niyogi of the University of California, Berkeley, USA has focused on this problem. Their paper, titled "Improving photosynthesis and crop productivity by accelerating recovery from photo-protection," has appeared in the 18 November 2016 issue of the journal Science.

Energy from sunlight is captured by the green pigment called chlorophyll in the leaves in order to conduct these chemical reactions. But this energy can also damage the leaves (recall how sunbathers in beaches can get sunburnt). Plants protect themselves from such light-induced damage by releasing heat (but we use sun-tan lotions or dark glasses for protection). Now, such "quenching" of excess solar energy must be quick. If it takes too long (often as long as half an hour) to "relax" and resume the cycle, it may be thought of as a "waste of time." If only we can hasten this process (termed non-photochemical quenching, abbreviated as NPQ) of recovery safely, argues this research team, we may be able to improve crop productivity.

#### **Quick fix**

The team studied how plants "fix" or adjust their photosynthetic cycle as their leaves experience light and shade- as in a natural environment. In full sunlight, NPQ

is activated so as not to harm the chlorophyll too much. But as clouds shade the sunlight, in such a low-light situation, NPQ is reduced. Hastening the NPQ process, argues the team, could increase the efficiency of the photosynthesis cycle by anywhere between 8 per cent and 30 per cent. This, in turn, could be a promising strategy for improving crop yield.

Such a switching of NPQ levels is governed in plants by the action of three proteins. One protein abbreviated as ZEP speeds up the NPQ rate. A second one, termed VDE, balances ZEP activity, acting as a moderator, while a third one called PSBS adjusts the NPQ level. If one can play with the levels of the three proteins, one can in turn adjust the efficiency of photosynthesis and hence the crop yield.

To this end, the group inserted the genes for VDE, PSBS and ZEP and obtained a genetically engineered plant of tobacco as the proof-of-principle plant. Why tobacco? When this question was posed by the science writer Hannah Martin Lawrenz, Dr Long is reported to have responded: "Because it is easy to transform [genetically], and it is a crop, so it produces the layers of leaves we needed. [Also] because the process is the same in rice, soybeans, wheat, and cowpea, we have strong confidence that this should work for food crops. But the next step is making the same changes in those crops, which are much more difficult to transform".

Plants with all the 3 genes VDE, PSBS and ZEP were named VPZ plants and their performance compared with normal, unmodified (scientists call such controls "wild type" or WT) tobacco plants. The VPZ plants displayed faster relaxation of NPQ and they were seen to recover and engage in photosynthesis sooner. The researchers next made the light falling on the plants fluctuate, so as to mimic light and shade (or day and night), and compared the performance of VPZ with that of WT. Here again, the genetically engineered VPZ plants performed better in low light than WT.

And then, in order check the productivity in the field as crops, they planted both types of tobacco plants in the university field. Plants from VPZ had higher leaf area (better for photosynthesis), increased leaf, stem and root weights and anywhere between 14 per cent and 20 per cent more dry weight per plant than the unmodified plants. These findings, the researchers write, provide proof of concept for a route to obtain a sustainable increase in productivity for food crops and a much-needed yield jump. Yes, the plants are genetically modified. But



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note, the genes are already plant-based and not foreign to the plant kingdom. So, there should be far less, if any at all, objection or opposition from anti-GM activists.

### **IIT scientists develop irrigation maps of India**

For the first time, high-resolution maps of irrigated areas of India from 2000-2015 have been prepared using remote sensing data. The maps were validated with ground-based survey data. High-resolution irrigated water maps are essential for estimation of irrigation water demand and consumption on a spatial scale, crop productivity assessments and hydrologic modeling.

The maps were developed by a team led by Dr. Vimal Mishra from the Civil Engineering Department, Indian Institute of Technology, Gandhinagar, and Gujarat. The results were published in *Scientific Data*, a journal from the Nature group.

While the irrigation maps developed by the Food and Agriculture Organisation (FAO) are of low resolution, the high-resolution maps of International Water Management Institute (IWMI) are available for just one year and do not cover the entire country.

“So we developed annual irrigated area maps at a resolution of 250 meters for the period 2000-2015 covering all the agro-ecological zones of India,” says Dr. Mishra. “We used the remote sensed vegetation index data from MODIS [Moderate Resolution Imaging Spectroradiometer] and high resolution (56 metre) land use/land cover data from the National Remote Sensing Center (NRSC) to prepare the maps.”

In the case of some States the maps tend to overestimate the irrigated areas while in others it underestimates. “Generally, humid areas lead to overestimation of the irrigated areas because of less variation in peak vegetation index, which is used as a threshold to identify irrigated and non-irrigated areas.

Also, the resolution of remotely sensed vegetation index data may not be able to fully capture irrigated areas of small land holdings in India. And, a 250-metre pixel is considered fully irrigated even if there is partial irrigation in a small field within a pixel,” he says. However, the maps have better accuracy in the case of arid and semi-arid regions as vegetation is restricted to areas that are irrigated and therefore the vegetation index truly reflects the vegetation health. “For most States we found our estimates of irrigated area are better in accuracy than the maps developed by IWMI,” he says.

“Since a majority of agro-ecological zones of India fall

in water-limited conditions, we assume that our method is effective for India,” they write. The developed dataset showed better accuracy against the ground-based survey than previously available datasets.

The estimation of irrigated area can be further improved if vegetation index data is available at higher spatial (to resolve small land holdings) and temporal resolution (to accurately capture crop growth cycle, which is essential to differentiate crops that are irrigated and not irrigated). “We have plans to update the repository every year. By February 2017 we will upload the irrigated area data [in the form of maps] for 2016,” Dr. Mishra assures. The irrigation maps from 2000 to 2015 for the entire country are available in a Geotiff format in a repository and can be freely accessed by researchers and others.

To highlight the trend and response of irrigation to rainfall variations, the authors chose the Indo-Gangetic Plain, which had witnessed severe drought in 2002 and 2015. To understand how unusual the 2015 drought was, the authors looked at the magnitude of deficit in 2015 monsoon rainfall and also looked at the long-time data from IMD.

“When we analysed the data, two regions — Indo-Gangetic Plain and Marathwada regions — were very distinct. These two regions faced very severe monsoon rainfall deficit in 2015,” he says. “We hypothesised that single monsoon deficit alone cannot result in a severe water shortage in these regions that was witnessed in the post-monsoon season of 2015 and summer of 2016.” The GRACE satellite data showed an alarming depletion of groundwater in the post monsoon season of 2015. The combined depletion of surface and groundwater resources was caused by the two consecutive droughts over the Indo-Gangetic Plain region.

“The deficit for two consecutive years 2014 and 2015 was 51 per cent. The drought in the Indo-Gangetic plain based on two consecutive monsoon rainfall deficits was ranked one during the period of 1906-2015. Statistical analysis showed that the two-year drought was unprecedented and had a return period of more than 500 years. It means low probability of two consecutive years being drought years,” says Dr. Mishra.

### **Australia wants India to be a ‘consistent buyer’ of its cotton**

Australia, the fifth-largest exporter of cotton, is looking at India to emerge as a consistent and major buyer of the commodity.

An eight-member delegation representing the Australian



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Cotton Shippers' Association held meetings in Ludhiana, Mumbai, and Coimbatore between February 27 and March 3.

"We came to promote and enhance the use of Australian cotton," Matthew Bradd, chairman of Australian Cotton Shippers' Association, told The Hindu here on Thursday. "We want India to become a consistent buyer of our cotton."

Australia has close to 1,200 cotton growers and can supply even small quantities to India. China purchased more than 30% of Australia's cotton production last year. However, this was lower than its usual purchase.

"India is a big market for cotton and spinners in India said they have had good experience with Australian cotton," he said.

Hamish McIntyre, vice-chairman of Cotton Australia and a member of the eight-member delegation said India used to purchase 5-7% of cotton produced in Australia every year. In 2016, it shot up to close to 23 % due to a drop in production in India.

Indian textile mills can use Australian cotton as a blend to produce high-value garments. The area under cotton production was increasing in Australia, Mr. McIntyre said. K.N. Viswanathan, vice-president of Indian Cotton Federation, said that Australia's output was limited until last year. India is the largest producer and consumer of cotton globally.

PAU develops country's first BT cotton varieties  
Punjab Agricultural University, Ludhiana, said it has successfully developed the country's first Bt cotton varieties. The ICAR has identified three varieties, namely PAU Bt 1, F1861 and RS 2013, for cultivation in Punjab, Haryana, Rajasthan. It is a cheaper alternative to Bt cotton hybrid seed. PTI

### Indian researcher uses novel strategy to increase wheat yield

Besides increased yield, the treated plants also proved to be more resilient to drought-like conditions

Using a novel route, an Indian researcher has been able to increase wheat grain yield by 20% and also improve the resilience of wheat to environmental stress such as drought. By using a precursor that enhances the amount of a key sugar-signalling molecule (trehalose-6-phosphate (T6P)) produced in wheat plant, Dr. Ram Sagar Misra, from the Department of Chemistry, University of Oxford and currently with the Department of Chemistry, Shiv Nadar University, Greater Noida, has been able to increase the amount of starch produced and, therefore,

the yield.



#### The technique

The T6P molecule stimulates starch synthesis, which in turn, increases the yield. Since the pathway of T6P molecule is the same in other plants, the yield can potentially be increased by using suitable precursors. The results were published in the journal Nature. Dr. Misra is one of the authors of the paper.

Dr. Misra and researchers from UK used four precursor compounds to increase the amount of T6P produced in the plant. While genetic methods can increase the T6P level two-three fold, the four precursor compounds were able to achieve 100-fold increase in the sugar-signalling molecule level compared with plants that did not receive the molecule. Dr. Misra and others tested the effect of four precursors by dissolving the molecule in water and feeding this to the roots of Arabidopsis thaliana plants. Compared with controls, the precursor-treated plants produced higher amount of T6P molecule and starch when exposed to sunlight.

In field trials using wheat, a tiny amount of precursor given to the plant increased the yield significantly — the grains produced were bigger as the amount of starch content in the grains increased by 13-20% compared to controls that got only water. "A particular precursor molecule — ortho-nitrophenyl ethyl — showed the best results in both A. thaliana plants and wheat studies," he says. "The uptake of this molecule by the plants was much more than the other three molecules and the precursor took less time to release T6P."

To study the resilience of wheat to drought-like conditions when treated with the precursor molecules, the researchers carried out two different studies.

#### Resilience to drought

In the first case, four-week-old wheat plants already treated with the precursor molecules were not watered for nine days to simulate a drought-like condition. "The plants were almost dying. When we watered the plants

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after nine days, only those that were pre-treated with the precursors were able to regrow while the control plants did not survive,” says Dr. Misra.

In another experiment, four-week-old wheat plants that were not watered for nine days were sprayed with the precursor molecules. “The regrowth of plants sprayed with the molecule was substantial when the plants were watered a day after treatment. We saw regrowth of new tissue and also survival and growth of existing tissue,” Dr. Misra says. “This also showed that the molecule could enter the plants directly when sprayed.”

“These two studies showed that wheat plants were able to survive environmental stress if treated with the precursors. The molecule 2 (dimethoxy(ortho-nitro)benzyl) was better in battling stress,” he says. More trials on a larger scale are needed to confirm the role of the precursor molecules in increasing yield and withstanding drought-like conditions.

### Reforming trade in agro-products

Trading of agricultural commodities in India has been crippled by multiple structural and regulatory issues. Traditionally, the lack of liquidity, quality testing and assurance, and guarantee of delivery kept small farmers as well as institutional traders sceptical of the market. The grant of repository licences to CDSL and NCDEX and the ongoing discussions by SEBI to introduce commodity options are positive signs.

Currently, a farmer can take the produce from the farm to a certified warehouse, get the quality inspected and receive a negotiable warehouse receipt (WR) with a unique identity (ISIN). This WR can be traded on the exchange like any other negotiable instrument.

Theoretically, this works fine and has several advantages. It provides better price realisation for farmers, safer collateral for lenders like banks and NBFCs, a more efficient market place for hedgers and speculators, and better quality and lower disruptions in supply for the end customer. But, in practice, the system faces many issues, as below:

#### Participation by farmers

The typical farm size in India is very small and the total produce of a farm would probably be lower than a single tradable lot at the exchange. Creating a pool of farmers through initiatives like Farmer Producer Companies (FPC) is a good idea, but the initiatives have been slow to take off.

Usually the farmer, either directly or through a broker, sells the produce based on the prevailing MSP. Storing

produce in a warehouse is often not an option for these farmers. The main reason for this is that the MSP has become the market price instead of being the minimum assured price. It means that the farmer is not incentivised to carry the goods.

In countries like Australia and Canada, there are “pool” programs that allow the farmer to sell their harvest at the average price of grain over a period of time. The government could consider enhancing the MSP with more contracting options to allow the farmer to participate in the market movement.

#### Private participation

Market intervention by the government is a major deterrent to private participation. The suspension of forwards contracts, ban on trading of chana and castor in 2016 have had an impact on the volumes and market confidence.

The other issue is that the storage cost at certified warehouses is higher than the cost at the non-certified ones; this directly impacts the percentage of produce that gets dematerialised.

Finally, in order to encourage private companies to directly buy from the farmers, the rules for purchase and payments at various APMCs need to be standardised and the government should consider introducing standard price adjustments based on location of the farm and the quality parameters. This will help the farmer sell goods at the farm gate conveniently with minimum wastage, and will help private companies adjust the MSP based on the pre-set transportation costs and quality of produce.

Currently, due to the above issues, only a niche set of private companies use the agriculture contracts on the exchanges.

In summary, our current state is a reflection of the journey we have chosen based on our needs as a country. Food security and rural economy have rightly been the main factors influencing government policies in this sector. The government now needs to create an efficient and robust market to attract investments and talent required for ensuring a bright future for agriculture in India.

(The author is director, business consulting, Sapient Global Markets)

### Cotton looks stable in FY18: Ind-Ra

India Ratings (Ind-Ra) has maintained a stable outlook for cotton textiles for the next financial year following steady input prices, healthy capacity utilisation and healthy domestic demand.

The agency has revised its cotton outlook to stable for fis-

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cal year 2017-18 from negative for the fiscal year 2016-17.

The status will stem from fiscal incentives and implementation of the Goods and Services Tax (GST) that will improve the industry's export competitiveness, Ind-Ra said. Favourable trade agreements with the U.S. and Europe will also lead to a significant increase in India's exports and a higher-than-expected domestic demand would be positive for the sector, it added.

Moreover, Ind-Ra said, the U.S.' exit from the Trans-Pacific Partnership is likely to realign textile trade and investments, which were diverted to Vietnam over FY16-FY17, towards the Indian subcontinent.

The stable cotton outlook is in view of an increase in acreage, a rise in supply in the first quarter of FY18 (due to demonetisation) and a decline in global inventory assisting with a balanced supply, Ind-Ra said. It also expects operating profitability levels of Indian cotton ginners and exporters to moderate in FY18.

### **ICRISAT, ICAR join hands for crop improvement**

In a bid to benefit small farmers in India and globally, Indian Council of Agricultural Research (ICAR) and the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) would work together on crop improvement and agronomy programmes for grain legumes and dryland cereals.

ICAR and ICRISAT, recently signed an agreement in New Delhi, in which climate smart crops, smart food and digitalisation of breeding database were identified as some of the core areas of research.

ICAR director General Dr Trilochan Mohapatra said that the collaboration will benefit Indian farmers and they are committed to achieve real impact through the partnership with continuous monitoring by both sides.

He said other areas of focus over the next three years include - integrating systems modelling tools for upscaling climate resilient agriculture, developing genetic and genomic resources of finger millet and enhancing genetic gains for priority traits.

Meanwhile, ICRISAT director general Dr David Berginson said that dryland cereals and grain legumes are branded as smart foods – good for consumers, farmers and the planet as they diversify farming systems and help smallholder farmers adapt to climate change.

"We enjoy a strong partnership with ICAR so we can deliver real results to improve the lives of farmers," he added.

On crop improvement front, the pact will facilitate re-

search on pigeonpea and chickpea for insect resistance.

### **Mother Dairy eyes nutrition products**

Mother Dairy Fruit & Vegetable. A wholly-owned subsidiary of National Dairy Development Board (NDDB), is planning a foray into the nutrition products segment, managing director S. Nagarajan said.

Lifestyle changes and the "gender-specific" needs of people in the 11 to 59 years age-group, has created the need for products which will help overcome deficiencies in calcium, iron, vitamins and micronutrients, Mr. Nagarajan said after unveiling the company's milk portfolio here, under a new brand 'Dailicious.'

Although a three- to five-year timeline was being looked at for entering the nutrition product segment, no firm dates had been fixed yet, he said.

Indications are that fibre-packed vegetable juices may be among the initial offerings.

Mother Dairy has an innovation centre near Delhi, where a Rs. 15 crore investment was made this year, he said.

The firm, eyeing a Rs. 10,000 turnover in 2019 (from about Rs. 8,000 crore estimated this fiscal), has four product segments – milk, value-added products, edible oil (Dhara brand) and fruits and vegetables. "The fastest growth is from value-added segment of ice cream, dahi, butter milk, followed by edible oil, fruits and vegetables, and milk" Mr. Nagarajan said.

Sandeep Ghosh, Business Head, said that the introduction of the milk portfolio will strengthen the company's position in Kolkata.

NDDB ran the 'Operation Flood' project in West Bengal till the '90s when it handed over the brand to the state government, on the understanding that the latter would have exclusive rights to the Mother Dairy brand for milk products.

### **Twinking photosynthesis for a better crop yield**

We depend on plants for much of our food, clothing and shelter. Plants depend on the material in the soil and earth below, water, air and sunshine for their growth. Sunlight is thus an essential raw material for the growth of plants. Using sunlight, water and carbon dioxide present in air, plants synthesise what is needed for much of their own metabolic needs (and thus our needs). This process, known as photosynthesis, is carried out largely by the leaves (and similar appendages) in plants. Humans and many animals are dependent on the efficiency with which plants photosynthesise, grow and multiply.

As human population increases, we would need more of

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crops in order to cater to the global demands for food. It thus becomes important to study ways in which plant productivity can be increased. One way of approaching this is to find ways in which photosynthesis can be improved. An international team of researchers, led by Dr Stephen P. Long of the University of Illinois and Dr Krishna K. Niyogi of the University of California, Berkeley, USA has focused on this problem. Their paper, titled "Improving photosynthesis and crop productivity by accelerating recovery from photo-protection," has appeared in the 18 November 2016 issue of the journal Science.

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sponded: "Because it is easy to transform [genetically], and it is a crop, so it produces the layers of leaves we needed. [Also] because the process is the same in rice, soybeans, wheat, and cowpea, we have strong confidence that this should work for food crops. But the next step is making the same changes in those crops, which are much more difficult to transform".

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And then, in order check the productivity in the field as crops, they planted both types of tobacco plants in the university field. Plants from VPZ had higher leaf area (better for photosynthesis), increased leaf, stem and root weights and anywhere between 14 per cent and 20 per cent more dry weight per plant than the unmodified plants. These findings, the researchers write, provide proof of concept for a route to obtain a sustainable increase in productivity for food crops and a much-needed yield jump. Yes, the plants are genetically modified. But note, the genes are already plant-based and not foreign to the plant kingdom. So, there should be far less, if any at all, objection or opposition from anti-GM activists.

#### **Highly pungent capsicum varieties have higher antioxidant property**

A team of Indian researchers from the School of Life Sciences, Jawaharlal Nehru University and other institutions has successfully decoded the molecular basis of extreme fiery hot (pungency) property of Bhut jolokia (Capsicum chinense) which is native of northeast India; Bhut jolokia has the highest pungency level in the world.

In the study, many varieties belonging to *C. chinense*, *C. frutescens*, *C. annum* were studied and comparative analysis carried out for pungency, vitamins and other metabolites. The high level of pungency and vitamins was found to be positively correlated with high antioxidant activities — the higher the pungency of the capsicum variety the higher was its antioxidant property. The results were published in the journal PLOS ONE.

"Pungency and vitamin C show high correlation, and

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these two along with other metabolites have high antioxidant activity," says Sarpras M from the School of Life Sciences, JNU and the first author of the paper. "When we tested the extract on in vitro cell-free assays the highly pungent capsicum varieties showed very high potential for free radical scavenging activity compared with low pungent varieties. We compared capsicum varieties with low, moderate and high pungency."

To compare the free radical scavenging capacity of the capsicum varieties, the researchers generated free radical through chemical reactions and tested how effectively the extracts from different varieties scavenged the free radicals.

#### **Effectiveness in mice**

"We have now tested the effectiveness of the extract to scavenge free radicals in mice and cancer cell lines. We have got some encouraging results," says Sarpras.

"The capsicum Bhut jolokia [popularly known as ghost chilli] has more anticancer property compared with other capsicum varieties," Ajay Kumar from the School of Life Sciences, JNU and one of the authors of the study.

"The scavenging property is useful in humans and animals as it neutralises the free radicals which are otherwise harmful," says Dr. Nirala Ramchiary from the School of Life Sciences, JNU and the corresponding author of the paper.

Seventeen varieties of *C. chinense* species had high pungency of over 0.9 million scoville heat unit, which is higher than what has been previously reported.

While earlier studies have looked at antioxidant property of capsicum, the studies were limited to a few varieties. But for this study the researchers examined 136 varieties of capsicum from northeast India belonging to three species — 63 varieties of *C. chinense*, 17 varieties of *C. frutescens* and 56 varieties of *C. annum*. Maximum pungency was seen in *C. chinense* varieties followed by *C. frutescens*; *C. annum* had the least pungency.

#### **Genes identified**

The team identified crucial genes involved in pungency development. A majority of candidate genes involved in capsaicinoid biosynthesis pathway showed many-fold higher expression in *C. chinense* species compared with *C. annum* species. This suggests that the possible reason for the extremely high pungency seen in some *C. chinense* varieties "might be due to higher levels of candidate gene expression". Variations in the pungency-related genes might also be causing variation in the level of pungency. "Around 10 metabolites which are precursors of capsaicinoid production pathway indirectly enhances

the pungency," says Sarpras.

"The major objective of the study was look at the pungency of different capsicum varieties belonging to different capsicum species and identifies the genes regulating pungency biosynthesis. We were successful in identifying the crucial genes involved in pungency development," says Dr. Ramchiary. "We are looking at ways of regulating the pungency development in capsicum fruits so it can be manipulated."

In addition to testing the pungency and testing its effectiveness in scavenging free radicals, the authors also studied 65 metabolites found in capsicum. "No harmful metabolite was found. We also did not find significantly unique metabolite differences in the three species studied. But there were differences in the quantity of metabolites in the three species," says Dr. Ramchiary.

#### **Indian researcher uses novel strategy to increase wheat yield**

Using a novel route, an Indian researcher has been able to increase wheat grain yield by 20% and also improve the resilience of wheat to environmental stress such as drought. By using a precursor that enhances the amount of a key sugar-signalling molecule (trehalose-6-phosphate (T6P)) produced in wheat plant, Dr. Ram Sagar Misra, from the Department of Chemistry, University of Oxford and currently with the Department of Chemistry, Shiv Nadar University, Greater Noida, has been able to increase the amount of starch produced and, therefore, the yield.

#### **The technique**

The T6P molecule stimulates starch synthesis, which in turn, increases the yield. Since the pathway of T6P molecule is the same in other plants, the yield can potentially be increased by using suitable precursors. The results were published in the journal Nature. Dr. Misra is one of the authors of the paper.

Dr. Misra and researchers from UK used four precursor compounds to increase the amount of T6P produced in the plant. While genetic methods can increase the T6P level two-three fold, the four precursor compounds were able to achieve 100-fold increase in the sugar-signalling molecule level compared with plants that did not receive the molecule. Dr. Misra and others tested the effect of four precursors by dissolving the molecule in water and feeding this to the roots of *Arabidopsis thaliana* plants. Compared with controls, the precursor-treated plants produced higher amount of T6P molecule and starch when exposed to sunlight.

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In field trials using wheat, a tiny amount of precursor given to the plant increased the yield significantly — the grains produced were bigger as the amount of starch content in the grains increased by 13-20% compared to controls that got only water. “A particular precursor molecule — ortho-nitrophenyl ethyl — showed the best results in both A. thaliana plants and wheat studies,” he says. “The uptake of this molecule by the plants was much more than the other three molecules and the precursor took less time to release T6P.”

To study the resilience of wheat to drought-like conditions when treated with the precursor molecules, the researchers carried out two different studies.

#### **Resilience to drought**

In the first case, four-week-old wheat plants already treated with the precursor molecules were not watered for nine days to simulate a drought-like condition. “The plants were almost dying. When we watered the plants after nine days, only those that were pre-treated with the precursors were able to regrow while the control plants did not survive,” says Dr. Misra.

In another experiment, four-week-old wheat plants that were not watered for nine days were sprayed with the precursor molecules. “The regrowth of plants sprayed with the molecule was substantial when the plants were watered a day after treatment. We saw regrowth of new tissue and also survival and growth of existing tissue,” Dr. Misra says. “This also showed that the molecule could enter the plants directly when sprayed.”

“These two studies showed that wheat plants were able to survive environmental stress if treated with the precursors. The molecule 2 (dimethoxy(ortho-nitro)benzyl) was better in battling stress,” he says. More trials on a larger scale are needed to confirm the role of the precursor molecules in increasing yield and withstanding drought-like conditions.

#### **‘Agriculture students ring in second green revolution’**

To bring about the second green revolution, students of agriculture should devote their knowledge to the development of farming and the welfare of farmers, Union Agriculture Minister Radha Mohan Singh said.

He was addressing the 55th convocation of the ICAR-Indian Agricultural Research Institute (IARI) in New Delhi. “As Pusa Institute is situated in Delhi, there has been continuous development of agriculture in the adjoining States like Punjab, Haryana and western Uttar Pradesh. Two more agricultural research institutes, in Assam and Jharkhand, have been opened for the holistic development of agriculture nationwide,” he said.

Because of the adoption of crop varieties developed by Pusa Institute, “meaningful and multiple changes” had come about, he said. “Earlier, we depended on other countries for grain, but now we are helping other countries by providing [them] food security.” With the cultivation on 10 million hectares of wheat varieties developed by the IARI, 50 million tonnes of wheat was being produced. “Basmati rice accounts for Rs. 22,000 crore in the agricultural exports totalling Rs. 1 lakh crore, and of this, the Basmati varieties developed by Pusa Institute account for 90%,” he said.

A state-of-the-art automated phenomics facility, established by the IARI, would be useful in studying the environmental stress. “This facility will be used for developing plants that yield more by consuming less water and fertilizer,” he said. Mr. Singh said the ICAR-IARI had developed an innovative, eco-friendly and cost-effective technology for making waste water pollution-free and useful for irrigation.

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## MISCELLANEOUS

### **'Declare India country with FGM prevalence'**

As many as 30 women from the Dawoodi Bohra community have petitioned the United Nations demanding that India be recognised as a country where Female Genital Mutilation (FGM) or Female Genital Cutting (FGC) is practised.

The petition put up by the group called 'Speak Out on FGM' states that due to the secrecy around it, the act is ignored by the government and there is no data on FGM from India.

#### **'Practice continues'**

"We have been raising our voices for long but the practice continues. There has been barely any change on the ground level as the government has not responded to our pleas in any way. If the U.N. stands with us, the government will automatically take note," said Masooma Ranalvi, a 50-year-old publisher from Delhi and a member of Speak Out on FGM. "Many African countries have stopped the practice after U.N. intervention. We hope to have the similar change in our country," she added.

The World Health Organization defines FGM or Female Circumcision as all procedures that involve partial or total removal of the external female genitalia, or other injury to the female genital organs for non-medical reasons. Termed as khatna or khafz in India, it is commonly practised among the two million strong Dawoodi Bohra community.

"For hundreds of years, this practice is being continued under a shroud of secrecy and silence. No one outside of the Bohra community even knew of its existence. Even today young Bohra girls aged 7 or even younger sometimes are taken secretly and subjected to FGM/C," the petition states.

"At least 80 per cent of the Bohra girls are subjected to this act of violence. Unless the government stands behind us, the brutal act will continue," said Ms Ranalvi, who was subjected to FGM at a very young age.

But she ensured that her daughter, 22, was not put under the knife.

Since the group of like-minded women got together in 2015 under 'Speak Out on FGM,' they have taken up several campaigns to reach out to the community.

They started with the very first petition which was named

after their group that received 80,000 signatures.

Another campaign called 'Not My Daughter' started in April this year had over 150 Bohra mothers and fathers pledging that they will not put their daughter through the suffering.

A recent campaign called 'Éach One Reach One,' along with another group called Sahiyo, aimed at reaching out to at least one Bohra woman to have a conversation about khatna . The group has also reached out to the clergy in the community including its religious head Syedna Mufaddal Saifuddin.

#### **'Extremely uncouth'**

"I feel that the parents have absolutely no right to tamper with their children's body. Male circumcision is a common practice but there is some evidence to show its medical benefit. In females, there is absolutely no benefit. In fact the act of female cutting is carried out with an idea of reducing sexual pleasure or reducing libido in women," said Ahmedabad based gynecologist Sheroo Zamindar who was cut at an early age.

"I still can't forget that dark dingy room where I and my sister were taken," said Dr Zamindar adding that the procedure is carried out in an extremely uncouth manner and in a non-sterile environment. "If I had a daughter, I would have not done it for her," she said adding that many of her patients approach her to cut their daughters but she refuses.

The WHO also emphasises that the procedure has no health benefits for women. In India, the commonly practised form of cutting is clitoridectomy that involves partial removal of the clitoris, specifically the clitoral hood that is made of erectile tissue and protects the glans.

Bohra women fighting against the practice say that clitoral unhooding is also a form of genital cutting and violation of human rights.

"If we are declared as a FGM state by the U.N., there will be focus on our country," said Dr. Zamindar.

### **Plastic notes will help beat counterfeiting**

The government informed Parliament that it has been decided to print banknotes based on a plastic or polymer substrate in order to make counterfeiting them more difficult.

"It has been decided to print banknotes based on plastic/polymer substrate," Minister of State for Finance Arjun Ram Meghwal told Parliament .

"The process of procurement has been initiated."

The Minister also added that the government has initiated various steps to popularise cashless transactions follow-





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ing its announcement to demonetise high value currency notes from November 8 onwards.

#### **'Various steps taken'**

"Various steps have already been taken in order to popularise cashless transactions viz., waiving the MDR (Merchant Discount Rate) charges till December 31, 2016 by the banks to promote greater use of debit cards, reducing the USSD (Unstructured Supplementary Service Data) charges by TRAI from the current Rs. 1.50 per session to Rs. 0.50 per session for transactions relating to banking and payments, and waiver of the same by the telecom companies until December 31, 2016," Mr. Meghwal told the Parliament.

#### **India has just what hyperloop needs**

When Bibop Gresta, chairman and co-founder of Hyperloop Transportation Technologies, Inc. (HTT) met Union minister of road transport and highways Nitin Gadkari in the Silicon Valley, Mr. Gadkari mistook him for Tesla Motors Inc.'s founder Elon Musk. Mr. Gresta clarified his identity and now his California-based start-up is in talks with the transport ministry to build the hyperloop transportation system in India. HTT's system is based on the hyperloop concept, which was envisioned by Elon Musk. It is a new mode of passenger transportation that pushes a pod-like vehicle through a near-vacuum tube at airline speeds. According to Mr. Gresta, India needed such system. He has experienced the country's transportation problem first-hand when he landed in Bengaluru this month and had to travel by car from the airport. "Oh my God, it was crazy, I took forever. You guys drive like there is no tomorrow," he said. Edited excerpts.

#### **Why do you want to set up the hyperloop system in India?**

India has amazing potentialities right now because it has the right density, the lack of infrastructure and the political willingness to change. This combination of factors could be disruptive in a country that we know would be leading the world in the next few decades. India has everything in terms of the resources and minds. It is a responsibility to embrace innovation because it is the only way to actually fix the problem.

#### **Have you discussed it with the government?**

I actually met Mr. Modi (the Prime Minister) in the Silicon Valley and Mr. Gadkari (Union minister of transport and highways). Mr. Gadkari demonstrated a big interest for hyperloop and he also said it publicly. We have had a proposal on his table for a couple of weeks. We had a very long commercial conversation with Mr. Gadkari. He said

he wants to do it. He said that he is ready to give us land. So, we have to see if he wants to do it or not.

#### **Considering infrastructure challenges, can it happen in India?**

It needs to happen, this is the country that needs it more. How can you fix the problem? It is not building other roads. This system is broken in every possible way. The rails are not a viable way to fix the problem as you see it. They are too expensive and are not profitable and are subsidised by the state. We need a system that can be profitable which is efficient and fast and that is hyperloop and we are ready to build it.

#### **We have read about such systems in science fiction books, how far is it from reality?**

We have the technology. We are the only company that owns the trademark hyperloop in 20 countries, including India. We are the only company that has licensed technology tested by the Lawrence Livermore National Laboratory. We have the vacuums made by a labelled company that is the inventor of the vacuum pumps. We have all the elements to build hyperloop. We are not inventing anything new. We are putting together technology that already exists. We are doing it in a very smart and efficient way. We can actually build it right now. There is criticism that you will never be able to build it right away. Well, I have bad news for these naysayers. Hyperloop can be built on top of existing infrastructure like rail, highway and can be built (along) side. For example a highway between Pune and Mumbai... Give us the land and we will build.

#### **Globally over a million people die each year as a result of road traffic crashes, can this system save lives?**

You have to understand 80 percent of the fatalities are caused by human error. We are completely managed by computers and supervised by humans. Our system implements what we call 'swarm intelligence' like the ants or the bees. The ants are capable of forming a line and with antennas and pheromones; they are able to communicate almost at the speed of sound. We are using a similar system. The first capsule analyses the tube and communicates to the next one. It is not only capable of controlling the systems through sensors and the mother-ship but in the case of lost communications, the capsules are intelligent (enough) to react, slow down and stop. You are always able to stop the capsule and evacuate the people safely.

#### **But don't you think high-speed trains like in Japan and China make more sense?**

You have to imagine, in our system, you don't need an

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electrified truck on the ground like the high-speed rail that uses too much energy. It costs too much because you have to bring the system to superconductivity. The hyperloop is a very simple system. Imagine you have a capsule full of people and you put it inside a tube. You evacuate the tube from the air so there is no resistance.

Now you can move the capsule at the speed of sound with very less energy. We are using a combination of renewable energy to produce electricity with the solar panel, the wind and the capsule also generates electricity while moving.

#### **Could you give the cost comparison?**

We should talk about where you are building it. Are you building it in Switzerland with mountains, bridges and tunnels or you are building it in a desert? But on average you can talk about \$40 million per kilometre compared to high-speed train which costs two times (as much) when we are lucky or six times when we are unlucky like in California.

#### **Are you working with any partners in India on hyperloop technology?**

We have 25 people working from India as part of our contribution programme. Besides our own employees, we also have a crowdsourcing approach. We have a community of almost 800 people. We have a programme called the hyperloop academy. We want to launch it in India to allow students to join our team and compete on developing and solving tasks related to the real hyperloop.

#### **A discovery makes a curator's heart pound**

It is an auctioneer's jackpot dream. A man walks in off the street, opens a portfolio of drawings, and there, mixed in with the jumble of routine low-value items, is a long-lost work by Leonardo da Vinci.

And that, more or less, is what happened to Thaddée Prate, director of old master pictures at the Tajan auction house in Paris, which is to announce Monday the discovery of a drawing that a curator at the Metropolitan Museum of Art says is by Leonardo, the Renaissance genius and master draftsman. Tajan values the work at €15 million.

"In a bit of a rush"

, this reporter was ushered into Tajan's private viewing room, where the drawing, of the martyred St. Sebastian, about 7½ inches by 5 inches, stood resplendent in an Italian Renaissance gold frame on an old wooden easel. In March, Mr. Prate recalled being "in a bit of a rush" when a retired doctor visited Tajan with 14 unframed draw-

ings that had been collected by his bibliophile father. Mr. Prate spotted a vigorous pen-and-ink study of St. Sebastian tied to a tree, inscribed on the mount "Michelange" (Michelangelo). "I had a sense that it was an interesting 16th-century drawing that required more work," said the elegantly suited Mr. Prate, speaking in the boardroom of Tajan's art deco premises. Mr. Prate, 55, asked for a second opinion from Patrick de Bayser, an independent dealer and adviser in old master drawings, who examined the St. Sebastian in Paris.

Mr. De Bayser asked: "Have you seen the drawing is by a left-handed artist?" (Leonardo was left-handed.) He also discovered two smaller scientific drawings on the back of the sheet. These diagrammatic studies of candlelight were accompanied by notes written in a minute, Italian Renaissance right-to-left hand. The two men looked at each other. "I said, 'You can't believe this is by Leonardo?'" Mr. Prate recalls. "But that would have been so incredible."

Tajan reached out to New York for a third, definitive view from Carmen C. Bambach, a curator of Italian and Spanish drawings at the Metropolitan Museum of Art. Bambach was an organiser of the Met's 2003 exhibition "Leonardo da Vinci, Master Draftsman," the first in the United States to take a comprehensive chronological overview of the artist's works on paper. That show included two studies, from museums in Hamburg, Germany, and Bayonne, France, that related to the "eight St. Sebastians" listed by Leonardo in his "Codex Atlanticus" sketch and notebooks, preserved in the Biblioteca Ambrosiana in Milan.

#### **"Exciting discovery"**

"My eyes jumped out of their sockets," Ms. Bambach said in a telephone interview, remembering her first sight of the drawing in Paris with de Bayser on the last day of March. "It exactly complemented the Hamburg St. Sebastian," she added, referring to how that pen-and-ink study of the saint tied to a tree also included inscribed optical studies on the reverse side, and to how the handwriting of the inscription was consistent in both double-sided drawings. "What we have here is an open-and-shut case. It's an exciting discovery."

In her view, the newly discovered drawing is the most highly developed and attractive of the three known studies associated with what may have been a lost painting of St. Sebastian. "My heart will always pound when I think about that drawing," she said.

Ms. Bambach estimates the drawing's date at 1482-85, during the early phase of Leonardo's period in Milan, when he painted his first version of The Virgin of the



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Rocks , now in the Louvre.

### Scans unveil secrets of world's oldest mummies

The world's oldest mummies have just had an unusual check-up.

More than 7,000 years after they were embalmed by the Chinchorro people, an ancient civilization in modern-day Chile and Peru, 15 mummies were taken to a Santiago clinic last week to undergo DNA analysis and computerized tomography scans.

The Chinchorro were a hunting and fishing people who lived from 10,000 to 3,400 B.C. on the Pacific coast of South America, at the edge of the Atacama desert. They were among the first people in the world to mummify their dead. Their mummies date back some 7,400 years — at least 2,000 years older than Egypt's.

Now, researchers are hoping to use modern medical technology to reconstruct what they looked like in life, decode their genes and better understand the mysteries of this ancient civilisation.

The 15 Chinchorro mummies, mostly children and unborn babies, were put through a CT scanner at the Los Condes clinic in the Chilean capital.

"We collected thousands of images with a precision of less than one millimetre," said chief radiologist Marcelo Galvez.

"The next phase is to try to dissect these bodies virtually, without touching them, which will help us preserve them for another 500,000 years." Using high-tech computer processing, researchers are busy reconstructing the mummies' muscles and facial features. "We want to see what they physically looked like, to reconstruct them and bring to life someone who died thousands of years ago," said Mr. Galvez. Researchers are also hoping to learn more about how the Chinchorro mummified their dead.

#### Careful reconstruction

The Chinchorro, who apparently had a complex understanding of human anatomy, would carefully remove the skin and muscles of the deceased. Using wood, plants and clay, they reconstructed the body around the remaining skeleton, then sewed the original skin back on, adding a mouth, eyes and hair. A mask was then placed over the face.

The result looks like something in between a statue and a person — eerily lifelike even after thousands of years. Mummification was an intimate process for the Chinchorro, said Veronica Silva, the head of the anthropology department at Chile's National Museum of Natural History.

"The family itself would make the mummy," she said.

The earliest mummies were unborn fetuses and newborns, she said.

The mummies were all made using the same basic process, but each one shows unique "technological and artistic innovations," she said. It was a process that evolved over time. The newest mummies are the most elaborate. Some 180 Chinchorro mummies have been discovered since 1903.

All were found outdoors, placed near the beach. The Chinchorro apparently did not build pyramids or any other structures to house them.

In fact, the Chinchorro civilization left no trace besides its mummies. "We are effectively talking about the oldest artificially mummified bodies in the world," said Silva.

"The Chinchorro mummies date to 7,400 years ago. That is to say, this system... existed 2,000 years before the first mummifications even began in Egypt."

Surprises have already begun to emerge from the CT scanner.

The smallest mummy, it turns out, was not a mummy at all. "There was no bone structure inside. It was just a figurine, possibly a representation of an individual who could not be mummified," said Ms. Silva.

Researchers also took skin and hair samples from the mummies to analyse their DNA, in hopes of identifying genetic links with the modern-day population. "We want to better understand their way of life — from their diet to whether we Chileans still carry their genes," said Ms. Silva.

### Cabinet's gives nod for International Solar Alliance pact

The Union Cabinet gave its ex-post facto approval to the proposal of the Ministry of New & Renewable Energy for the ratification of the International Solar Alliance's framework agreement by India. The ISA was unveiled jointly by Prime Minister Narendra Modi and French President Francois Hollande in 2015 at Paris on the sidelines of the COP 21 meeting of the UN Framework Convention on Climate Change.

### New data recovery centre of NTPC launched

A new data recovery centre of the National Thermal Power Corporation (NTPC) was inaugurated in the corporation's Southern region headquarters at Secunderabad , as an alternative IT back up facility for ERP system of the company.

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Corporation Chairman and Managing Director Gurdeep Singh inaugurated the facility spread over 2,000 square feet server farm area and embedded with Integrated Intelligent Building Management System (IBMS) and Data Centre Infrastructure Management (DCIM) Systems.

Mr. Singh said that the NTPC is the first public sector unit in India which has adopted complete change in the SAP hardware for migration to a new platform, and appreciated the engineers for the same.

He emphasized the need for extending the existing DRC facility even to joint ventures and other subsidiaries of the company.

### Archaeological find turns metro station site into museum

2,000 years of history unearthed in central Algiers, where authorities have shown that development and history can go hand-in-hand

An archaeological treasure trove on the site of a planned metro station in central Algiers is set to become a museum, opening a window on 2,000 years of history.

The site, close to the Algerian capital's UNESCO-listed casbah, has yielded remains from the city's Roman, Byzantine, Ottoman and French periods.



#### Spectacular view

"It was spectacular," said archaeologist Kamel Stiti, co-director of the excavations. "In one look, you could see two millennia of Algiers' history."

The remains, on the location of a Roman port town called Icosium, were discovered in 2009 when the Ministry of Culture ordered surveys along the planned metro line.

Archaeologists have since discovered coins, weapons, a public building paved with 5th century mosaics and a large 7th century Byzantine necropolis containing several dozen graves.

They also found parts of the Ottoman-era Es Sayida mosque, which French authorities flattened in 1831, shortly after their conquest of the North African country.

The colonial government put a public square in its place and called it King's Square and later, Government Square. It was re-named Martyrs Square after the country's hard-won independence in 1962.

Experts had believed that few pre-colonial artefacts remained on the site, but many of the ruins turned out to be surprisingly well-preserved, Mr. Stiti said.

#### Where there is a will

The 3,000-sq.m. site was deemed so important that the municipality adapted its plans for the metro station, a move Mr. Stiti said was a first in Algeria.

The site will now become a museum incorporated into the station, which, in turn, will take up less than half its planned 8,000 sq.m. The tunnel will go as deep as 35 metres in order to work around the remains.

The Martyrs Square station is set to open in November, part of an extension to the main metro line inaugurated in October 2011. The museum will open shortly afterwards, covering 1,200 sq.m. And organised chronologically. Some of the remains will be exposed to a depth of over seven metres.

"In Rome or Athens, museums present particular periods, whereas here the visitor can embrace the whole history of Algiers over 2,000 years," Mr. Stiti said.

He said the project showed that archaeology is not incompatible with development.

"It gives added value. One accompanies the other without slowing it down," he said.

"So as not to delay the work, which would add costs to the subway project, archaeologists have worked hard, including on public holidays."

The National Archaeological Research Centre (CNRA) and France's National Institute for Preventive Archaeological Research (INRAP) have been working on the dig since 2013.

More than 150 people of different nationalities and specialities have taken part, giving young Algerian archaeologists valuable opportunities to work on an important excavation.

Aicha, 70, who lives near the site, said she is looking forward to seeing the museum open.

"There will be no more hassle because of the building work, and I'll be able to travel by subway and visit the museum with my two granddaughters," she said.

Said, a 50-year-old high school history teacher, said he hopes there will be guided visits for young people "so they can take ownership of our city's several millennia of history."



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### Scientists discover five new sub-atomic particles

The find will contribute to understanding how three constituent quarks are bound inside a baryon

Scientists using the world's largest and most powerful particle accelerator have discovered a new system of five particles all in a single analysis.

The uniqueness of this discovery is that observing five new states all at once is very rare, researchers said.

The LHCb experiment is one of seven particle physics detector experiments collecting data at the Large Hadron Collider accelerator at CERN (European Organisation for Nuclear Research).

The collaboration has announced the measurement of a very rare particle decay and evidence of a new manifestation of matter — antimatter asymmetry, to name just two examples.

The new particles were found to be in excited states — a particle state that has a higher energy than the absolute minimum configuration (or ground state) — of a particle called Omega-c-zero.

#### Excited states

Omega-c-zero is a baryon, a particle with three quarks, containing two “strange” and one “charm” quark.

Omega-c-zero decays via the strong force into another baryon, called Xi-c-plus, (containing a “charm”, a “strange” and an “up” quark) and a kaon K-.

Then the Xi-c-plus particle decays in turn into a proton p, a kaon K- and a pion p+.

From the analysis of the trajectories and the energy left in the detector by all the particles in this final configuration, the LHCb collaboration could trace back the initial event — the decay of the Omega-c-zero — and its excited states. These particle states are named, according to the standard convention,  $O_c(3000)0$ ,  $O_c(3050)0$ ,  $O_c(3066)0$ ,  $O_c(3090)0$  and  $O_c(3119)0$ . The numbers indicate their masses in megaelectronvolts (MeV), as measured by LHCb.

The next step will be the determination of the quantum numbers of these new particles — characteristic numbers used to identify the properties of a specific particle — and the determination of their theoretical significance. This discovery will contribute to understanding how the three constituent quarks are bound inside a baryon and also to probing the correlation between quarks, which plays a key role in describing multi-quark states, such as tetraquarks and pentaquarks.

### Are scientists responsible for

### communicating their work to the general public?

After getting totally frustrated in a Twitter exchange (@GautamDesiraju) on this question, I decided to put my thoughts down in the more conventional form of an article, a means of communication with which scientists are far more comfortable.

One of my Twitter followers even said that one cannot say much in 140 characters, and this matter needs a bit more than that. Do scientists in publicly funded institutions need to communicate the gist of their work to the general taxpaying public? Are they morally bound to do it?

Does an increased awareness of science among lay persons increase its acceptability, and eventually create a better sense of its requirement, so that the public continues to pay for what some might even consider a luxury? On the other hand, is it easy to communicate high science to the public? Is there a difference in communicating the hard and soft sciences to non-specialists? In simplifying scientific matters for the sake of explaining it to lay people, does one lose the essential thread of the work? That there are many questions and no easy answers is what I found.

It's easy to quote Rutherford who said a good physicist is one who is able to explain what he is doing to the cleaning lady who comes every morning to tidy his laboratory. He got the important point here in that some kind of reality check on what one is doing is required for any scientist, but I really wonder if Rutherford meant this literally.

#### What is science?

Science is all about details, precision, accuracy, and it is indeed 99 per cent perspiration. The beauty and joy in doing science lies in those rare moments when the pieces of a puzzle magically come together. To adapt from Shelley, the shadow indeed becomes more important than the substance. I suppose one could put some of this together and disseminate a simplified, sanitised version to the public but in the end, science is a highly individualistic, personal affair. Most honest scientists will tell you that they are ever so grateful that they are being paid by their governments to do something that they would have done anyhow for free.

Does this make academic scientists parasitical, irresponsible, ivory-tower people, uncaring, cold and selfish? No! A resounding no! Many good scientists are often ill at ease in dealing with daily life situations. Scientists do communicate their work to non-specialists, especially in matters of obtaining funding or seeking promotions and



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awards. In many of these cases, the evaluation committees cannot consist only of people who are highly knowledgeable about the particular scientist and his/her area of work, but they are all scientists.

To ask scientists to actually “sell” their work to purely lay audiences in the name of increasing its “acceptability” would be taking them way beyond their comfort regions. Scientists are fully aware of their responsibilities. In universities and research institutes, their primary responsibility is to train the next generation of students through the expedient of conducting high-calibre research. In this research, their goal is absolute quality, ideally without any concern for possible practical applications.

This whole business of research outreach is fraught with problems. The standard sequence for scientific work should be patent, refereed publication, newspaper, with the first and third steps wholly optional in an academic institution. The danger in encouraging “communication” too much is that there would be a temptation to reverse the order and make it newspaper, mostly no publication (or controversial publication), and certainly no patent. This is already happening in some CSIR and DBT/DST laboratories today, sadly even from some IITs.

This is of course an extreme situation. My main problem with a scientist trying to disseminate his or her work to the general public is that the detail that is lost in communicating with the public is not a superfluous extra. The detail is the whole work. Without this detail, there would be no point in the work. Details are hard to understand and appreciate. Many breakthrough discoveries are incredibly hard to envisage, carry out and understand.

I finally come to the question of whether it is easier to “communicate” research findings in soft sciences like ecology, sociology and economics in contrast to hard sciences like physics, chemistry and biology. It is of course easier for a lay person to understand some very simple concepts in the soft sciences. Many of us would claim to say we understand something about climate change, body language or inflation as opposed to say hadrons, the Mannich reaction or epigenetics. So, while the soft sciences might “appear” to be more easily understandable than the hard sciences, I am sure that it is just as difficult for a practitioner to communicate the concepts and principles of these soft sciences to a general audience. But in the end, does a lay person understand even soft science which is easier to communicate?

What is lacking in India is a critically large mass of science communication experts, who on the one hand can

talk with scientists and on the other can disseminate essential aspects of the science to the public. This tribe is found in several foreign countries but in India the activity is non-coordinated and sub-critical.

Newspapers are definitely doing something, and The Hindu is a notable example. There should be a lot more of this in TV, which regrettably is interested in other things today. Our science academies are doing something but once again the activity is really sub-critical to make any real impact.

Some practising scientists have tried to get into science communication seriously. Whether their science suffered as a result is a moot point. Over the years, I have attempted my share of communicating scientific thoughts with the general public, perhaps a lot more than some of my contemporaries, but my considered opinion is that a practising scientist is not duty bound to communicate his or her work to the general public.

‘There is a huge price to pay when scientists remain in a cocoon’

Altmetric, a non-traditional alternative to impact-factor, measures the attention that research papers published in journals get from mainstream news outlets and social media. In 2016, Altmetric tracked over 17 million “mentions” in different platforms of 2.7 million different research outputs. Among the 100 “most-discussed” papers, three papers had 43 authors from India. This is much more than China and many European countries.

A February 11 paper on gravitational waves in the journal Physical Review Letters, with 41 authors from a few Indian institutions, has an Altmetric score of 4,694. The paper was covered by 92 news outlets (133 stories). A May 2 paper on Earth-sized planets transiting an ultracool dwarf star in the journal Nature had one Indian author. It has an Altmetric score of 2,064 and the paper was covered by 222 news outlets (260 stories). And the third paper on safety of injectable combination hormonal contraceptive in The Journal of Clinical Endocrinology & Metabolism has an Altmetric score of 2,258. The paper was covered by 234 news outlets (307 news stories).

The paper on gravitational waves was covered by most leading newspapers in India without hype or distortion, while the other two papers hardly got any mention here. The work on gravitational waves is surely not pop-science nor is the one on contraceptive an abstract piece of work. When co-authors of the last two papers outside India had interacted with journalists in their respective countries, what is holding back our scientists from inter-





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acting with the media?

#### Indian context

Journalists in India who regularly write on science know the reasons for this: The Inter-University Centre for Astronomy and Astrophysics (IUCAA) had alerted the media about the paper on gravitational waves in advance and also held a press conference to disseminate the news. Many senior scientists from the LIGO-India collaboration patiently explained the significance of the paper to journalists over phone. But there was no attempt by the authors of the other two papers or their institutions to communicate their work with the media.

Most reputed universities abroad have dos and don'ts for researchers on interacting with journalists when their papers are published. But many Indian scientists whose research and/or salaries are paid for with taxpayers' money do not consider it their responsibility to communicate the results of their work either directly or through the media. This trend is slowly changing, at least among the younger lot, particularly, as funding is becoming an issue.

Surely, not all types of research are amenable or suitable for newspaper stories. But even when they are, scientists in India rarely get in touch with journalists who regularly write on science. Many still have a notion that "scientists serve a society best by simply carrying out high-quality research" and publishing them in reputed journals, "leaving others to judge how it should be used".

Except for a tiny fraction, the vast majority of newspaper readers are lay people. The task before a science journalist is, therefore, to make the essence of the work accessible to lay readers. To scientists, newspaper articles, at best, serve to alert them and they would rely on original papers for detailed information. Many scientists in India fail to realise this.

While good science journalists are adept at conveying even complex topics in an accessible manner without compromising on scientific accuracy, in the hands of non-specialists, the information many times gets obscured or is even conveyed patently wrong. It is for the researchers to separate the wheat from the chaff and not shy away from the media completely.

It must be remembered that the media alone is not responsible for hyping up science. A paper published recently in PLOS ONE found that "many exaggerations were already present in university press releases, which scientists approve. Surprisingly, these exaggerations were not associated with more news coverage".

Social media does play an important role in disseminat-

ing information without distortion as scientists have full control over content. But it can at best supplement mainstream media and cannot substitute it. One hundred and forty characters are too little to convey any meaningful message. And scientists are no Amitabh Bachchans with a huge following so their reach is hugely limited.

But even when willing, the worst part is the bureaucratic hurdles many researchers have to face. It may come as a surprise to many that it is mandatory for researchers in many institutions to first seek the permission of their directors before discussing their work with journalists, even when their paper has already been published! Such stone-age policies set in stone are in place not just in many CSIR, ICMR and ICAR institutions but also a few IITs and IISERs.

There is huge price to pay when scientists remain in a cocoon. The most dramatic example of the negative fallout of scientists shirking their responsibility of communicating with the public is the misconceived notions among people about the safety of genetically modified organisms. And climate change best exemplifies the "negative consequences of poor communication between scientists and the public". It is to prevent nanotechnology from going the GM way that a few years back the Royal Society successfully engaged scientists to explain the basics, the advantages and disadvantages of nanotechnology with the public early on.

In Bob Dylan's words, "the times they are a-changin'". It is encouraging to see younger scientists and research scholars from premier institutions open to discussing their work. The ability of many PhD scholars to explain complex details of their work in an accessible way surprises me. What they at times lack is the ability to see the big picture. Only a couple of newspapers in India have a dedicated weekly page on science. In China, every newspaper has a daily page exclusively on science; there is a science newspaper as well. Indian scientists, science journalists and media organisations have much to do to improve and increase science coverage.

#### Spicy food leads to longer life

During the last five years, we have come to know a lot about how we eat what we eat. Several research publications that have appeared during this time throw some light on our gastronomic patterns, preferences and adaptations. We look at three of these.

#### We started out as vegetarians!

Recall we humans are descendants of apes and chim-



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panzees. These primates are vegetarians, and thus, early humans, too, must have been vegetarians. But unlike primates which stay put in Africa, we moved and migrated all over the world, adapting over time to any kind of food that was available - plant, fish or meat. Over time, some of us chose to stay eating plants alone, while others were less finicky. Either way, we adapted to circumstances. This would be an example of selective pressure. This adaptation is reflected in the variations in the genes that code for proteins and enzymes in the body, which convert the food we eat into essential molecules required for our cells to function efficiently. A research group from Cornell University focussed on one such gene called FADS, which codes for making what are called omega 3 and 6 fatty acids needed in our cells. The plant oils and fats that vegetarians consume are converted by their FADS to omega 3 and omega 6 fatty acids, which are vital components of cell membranes, helping in regulating the entry and exit of molecules across our cells. Meat eaters, on the other hand, obtain these omegas directly from the animal meat they eat.

The scientists, led by Thomas Brenna and Kumar Kothapalli, then decided to study the variation in the genes for FADS in vegetarians on one hand (for which they chose a group of strict traditional vegetarian families from Pune, Maharashtra) and in meat eaters from the U.S. on the other. While the FADS genes in vegetarians had two copies of what is called I, an insertion element (22 alphabets inserted within the gene sequence), FADS in meat-eaters had this element deleted (D). Veggies have I/I while meat-eaters have D/D in their chromosomes. The scientists found this I/I version to be highest in South Asian population but lower in Europeans and East Asians. (Incidentally, the I/I version is found in the FADS genes of Neanderthals). You are what you eat!

#### **The curry that Harappans ate**

The second exciting discovery came from the study by Arunima Kashyap and Steve Weber of Washington State University. They analysed the remains of starch grains from human teeth (as well as in a cooking pot excavated from the site) found in the ancient town of Farmane in Haryana (a well-known Harappan site) and identified ginger and turmeric in it. It thus appears that the curry that we make and use today traces its ancestry back to over 4,000 years ago!. Besides ginger and turmeric, Harappan food included lentils and moong dal, rice, millet and bananas. It is interesting how spices such as ginger and turmeric were used as early as 4,000 years ago in the

Indus Valley civilisation. We now know that ginger contains molecules that help against inflammation, control osteo-arthritis and modulate immunity. And we know largely from the excellent and exhaustive work done at the National Institute of Nutrition at Hyderabad (e.g., the book: "Turmeric - the Salt of the Orient is the Spice of Life," Dr Kamala Krishnaswamy, Allied Publishers, 2007) how golden the herb, turmeric, is.

But did the Harappans know about or use hot chili pepper (mirchi) or black pepper? While whether black pepper is innate to India or imported is still in dispute, chili pepper is clearly an import, brought into India by sea-faring traders from the West.

Dr K T Achaya and others point out that chili pepper, which owes its origin to Mexico and Central America, was brought into India and South Asia by the Portuguese in the sixteenth century. Prior to that, spicy food in India was largely made by the use of ginger, turmeric and other ingredients.

#### **Open access: The sorry state of Indian repositories**

India may not have a national open access policy in place, but the Council of Scientific & Industrial Research (CSIR), The Indian Council of Agricultural Research (ICAR), The Department of Science & Technology (DST), the Department of Biotechnology (DBT), The University Grants Commission (UGC) have open access policies that clearly mandate researchers to deposit their papers in institutional repositories. National institutes such as the IITs and IISc, too, have repositories and similar mandates.

Yet, of the 69 Indian repositories listed in the Directory of Open Access Repositories (DOAR) and Registry of Open Access Repositories (ROAR), only 12 added "at least one item during a month" during the period July 2016 to June 2016. Seventeen repositories did not add even a single item during the course of the year of study, while 40 were "irregular" in adding items to the repositories, says a correspondence published in Current Science.

Worse, some of them are not repositories in the strict sense — they do not host research papers, pre-prints or post-prints. Instead, they have theses, dissertations, book chapters, patents, annual reports, technical reports and research proposals to name a few.

#### **Lagging behind**

"Open access institutional repositories are clearly lagging behind despite the mandate," says Dr. G. Mahesh from



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the National Institute of Science Communication and Information Resources, New Delhi, and one of the authors of the article. "Individual researchers are required to deposit their papers in the repository but they don't. It is very difficult to motivate them to do it." One of the reasons why researchers do not deposit their papers in a repository is because they no longer hold the copyrights. "In over 95 per cent of cases, the researchers have already transferred their copyrights to the respective journals," he says. "Ideally, pre-prints of papers should be deposited in a repository. A large majority of publishers of subscription journals have no problem in researchers depositing preprints in a repository."

Since researchers transfer their copyrights to publishers when a paper is accepted, it is not possible to deposit the papers in a repository.

"Researchers get greater visibility when they deposit their pre-prints in a repository as anyone can read them. The institutions too gain. So it difficult to say why researchers don't do it," he says.

It is another matter that except in the case of the IISERs, individual researchers in most of the national institutes and government labs under CSIR, ICAR and ICMR do not even regularly update their publication list. It is not uncommon to find the publication list of many researchers, including those at IISc, not updated since 2013 and 2014!

### **Informational cascades in honeybee swarming behaviour**

Honeybees' behavioural patterns have proved to be notoriously difficult to study and there are many unique qualities to their group behaviour, such as swarming and decision making. A recent study by Nicole S. Carver and Damian Kelty-Stephen, of Grinnell College, USA, to be published in Physical Review E, has analysed the highly co-ordinated behaviour in honeybees ( *Apis mellifera* ), interpreting their communication pattern as an informational cascade process. The researchers analyse the data on dynamics of honey bee populations which have been studied by Paul Tenczar and four others, and published earlier in *Animal Behaviour*. Building on this, Carver and Kelty-Stephen identify the mathematical signatures of cascading behaviour seen in the observations of movement of bees in five observed experimental hives over a period of 5-7 weeks.

Swarming behaviour in honeybees is unique and interesting because it is a flexible and distributed decision-

making process. For example, when a group of bees decide to abandon their old hive, a set of scouts go out and forage for information on viable sites for a new hive. They return and communicate their information on likely places by a waggle dance. The rest of the bees, without apparent social pressures to conform, independently vote by a waggle dance of their own. Once a minimum number of positive votes (a quorum) is reached the bees make the decision to swarm without waiting for a unanimous endorsement.

### **Information sharing**

The present study interprets information sharing behaviour in bees as a multifractal information cascade. "A cascade is any sort of hierarchical structure in which different parts behave not just in response to small local events in their immediate surrounding but also in response to larger scale events and changes," says Dr Kelty-Stephen in an email.

Such cascades have been found in human interactions as well. Going by this, a similar analysis could be applied to human social networks, too. For instance, a person responds to a particular Facebook post not just because of that post but because of the larger set of posts across the entire newsfeed. Every person in a network might respond or interact with others differently because of the social or regional groups they belong to. "In short, social interactions are never just person-to-person, but instead, every agent interacting with another might bring her or his wider set of group memberships along into this interpersonal mixture."

According to Dr Kelty-Stephen, "This work suggests to me that we might have new tools and avenues for examining individual agents' behaviours and inferring group membership exactly in those cases where organisms do not advertise their affiliations on, say, a Facebook profile."

### **The reign of English as the language of science**

Depending on which source you access, there are anywhere from 17,000 to 28,000 academic journals around the world and 2.5 million articles published in them every year. Of these, anywhere between 15% and 35% of the journals are not in English language. In this connection, three researchers from Cambridge, UK, have published a paper in the (English language) journal *PLOS Biology*, titled: "Languages are still a major barrier to global sciences".

They point out that research publications in languages





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other than English lose out. This is particularly relevant and worrisome, since in such papers, a lot is reported on biodiversity, ecology and related subjects. And many of these journals do not find any place in standard link sites. Like it or not, English has willy-nilly turned out to be the lingua franca or the language of science and technology. And how has this happened? Several historical events have made this so. A major one is the migration of scientists from Europe and the Soviet Union, during and after the two world wars, to the two English-speaking nations, UK and USA, that welcomed them. Another is the result of colonisation of large chunks of the world, notably the Indian subcontinent, by Britain, and the introduction/imposition/gift/call-what-you-will of English to the local population. This allowed access to a cornucopia of material to the colonial subjects, many of whom took to learning and mastering English, and entering the larger world of science thereby. (An interesting reversal of this was by the Arabs who learnt and translated Sanskrit texts into Arabic and Persian thousands of years ago. Also interesting is the fact that two Indian scientists, Satyen Bose and Meghnad Saha translated scientific papers of Einstein and others, from German into (not Bengali but) English for their students).

I still recall how in graduate school at Columbia University, New York, in the mid-1960s, we had to learn Scientific German, French or Russian. And my brother had to go through three months of German language course before his degree in Germany. Gone are those days. Today, you don't need these language courses in the US universities, and many German ones use English for teaching! English reigns supreme today as the language of science and technology all over the world.

#### **Beyond English**

"Is there Science beyond English?" asked Drs R. Meneghini and AL Packer a decade ago in the journal EMBO Reports. They start their paper by pointing out that over the past 25 Nobel Prize winners in Literature, only nine wrote their masterpieces in English. The remaining 16 had to wait to get their work translated in to English to gain the attention of the Swedish Nobel prize committee! (Note, too, that Tagore got his Nobel Prize in literature after his poems were translated into English.) As the authors mentioned earlier note, "The translators faced the arduous task of transferring the splendor of the original text into a different semantic, syntactic and sometimes cultural context to make it appeal to a wider audience". So it is with science too. Gems of knowledge and wis-

dom - be they in Sanskrit, Chinese, Spanish or Swahili - became available to the wider world of scientists only upon translation. Many of us learnt for the first time the genius of the ancient Indian doctor Charaka only upon reading the brilliant translation of the Sanskrit text into English by Dr M.S. Valiathan. Likewise, the translation by Drs K.S. Shukla and K.V. Sarma, who did the same with Aryabhata's work, the work of the fifth century mathematician - astronomer Aryabhata. And we came to know of Kautilya's Artha Sastra, thanks to its discovery and first translation into English by R. Shamasastri during 1905-09. Taking a more recent instance, Dr. Tu You You, who received the Medicine Nobel Prize in 2015, found her clue in a centuries-old manual of clinical practice and emergency remedies, written in Chinese by Ge Hong of the East Jin dynasty. Most of Dr You's papers, including the one that identified the anti-malarial molecule, are in Chinese.

#### **Biodiversity**

This is the point that the three Cambridge authors emphasise in their PLOS Biology paper. They point out how important scientific information and research can be lost in areas such as in biodiversity, ecology, and conservation activities undertaken by local practitioners, and reported in their languages. For example, "the agency Wetlands International of Argentina has produced over 20 technical publications on the conservation and management of wetlands over the last 20 years, but only two are available in English.....Such knowledge generated by practitioners is often overlooked as 'grey literature' but forms a vital part of the evidence base". Conservation biologists who ignore them because they are not in English may end up reinventing the wheel. This would be true of other disciplines such as psychology, sociology and medicine. Initiatives to increase the quality and visibility of non-English publications might help to break down language barriers in scientific communication. One way, suggested in the February 4 issue of the magazine The Economist is the use of machine translation using computers and technological tools, designed specifically for chosen areas. Without such recognition and wider availability of local science, we would be poorer. As The Economist writes, local languages would be used socially and at home, but not for serious work. That would be a shame.

#### **Pleating membranes into compact forms**

A team of researchers, which includes faculty from TIFR Centre for Interdisciplinary Sciences, Hyderabad, has



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proposed a novel method to fold micron-sized sheetlike objects to spontaneously crumple into a compact space. There are many possible applications, for example folding soft membranes for use in nanoscale capacitors. They suggest using a special type of force field to catapult the soft object from a flat to a pleated compact form by inducing a “first-order phase transition” – the sort of transition that we see when water freezes.

#### **Miura Ori pleats**

We are familiar with the way folding paper methodically can be used to make beautiful origami shapes. While such objects are fun to make, they are also extremely efficient and compact. A definite type of fold, or pleat, called the Miura Ori tessellation is a way of making “flat foldable” forms – forms that pop-up when released. Such a folding technique can be immensely useful – some examples include compact packing of a sail or a foldable solar panel that can be used in a spaceship.

In biology, we encounter many systems where chemical reactions require a large surface area, but it needs to be compactly folded into a small volume – like a mitochondria. In other cases, a folded shape has to expand from a compressed two-dimensional form into three dimensions, as when a leaf unfolds.

In this context, it becomes useful to know how to make a soft membrane fold into a compact shape at small sizes ranging from the micrometres to nanometers. At that size Brownian motion, caused by the thermal fluctuations in the medium, usually play a highly disruptive role. “Imagine that you need to produce origami structures from sheets at very tiny length scales and for soft objects and in the presence of Brownian motion caused by thermal fluctuations. Normal manufacturing techniques will be very difficult under those circumstances. In such cases, it is useful if, somehow, the sheet folds all by itself, spontaneously, into a specified structure,” says Surajit Sengupta, Professor and Dean, TCIS, Hyderabad, and one of the team members, in an email.

The team proposes a way in which applying an external field will cause an elastic membrane to spontaneously fold itself into pleats. The resulting structure could be of different types and is determined by the magnitude of the field and the external strain.

The field acts by setting up “cameras” and “laser traps” whose positions may be adjusted by a feedback mechanism to give a bias to the fluctuations of atoms. More precisely, this biases the so-called non-affine fluctuations – basically, those fluctuations of the component atoms

that are not simply rotations and uniform stretches about their mean positions. This is used to calculate the forces to be applied locally to enact the phase transition into a pleated structure.

#### **Stable models**

With current technology it is possible to create various structures, but it is not always possible to ensure that they are stable. “This theoretical work suggests how one such stable arrangement, made the way they describe, could have a ‘pleated structure’.

This work is a nice example of how computer simulations can guide the design of materials with special properties,” says Gautam Menon of Institute of Mathematical Sciences, Chennai, who is not involved in this research.

#### **If music be the food of love, play on!**

Music is a mood-maker. How music affects the listener’s mood has long been a subject of study by psychologists and neuroscientists. Music, indeed, sound itself, affects the state of mind we are in for the moment. Volunteers who were put in a ‘happy’ mood listening to soothing music were asked to identify the facial expression of an individual or a face. They generally found the expression ‘happy’ or positive. And while ‘sad’ music (or just noise) was played, they identified the expression to be negative. (Is this the reason for the ‘mood music’ played in elevators in buildings - to keep the passengers in a friendly mood?) Sound cues affect the state of an individual mind leading to interpretation of visual emotions.

The reverse also appears true. Watching the anga chesh-tai - the body/face distortions - a singer makes goes to affect (at least my) appreciation of the beautiful elaboration he makes of the musical phrases. It would appear far better to hear him on the radio or CD. The audio affects the visual, and the visual, the audio. The late musician M.S. Subbulakshmi was a grand exemplar of this interdependence. (There actually are some killjoys who had criticised some women singers who come dressed in ‘showy’ silk saris as being ‘impious’.)

What actually happens in the human brains during such experiences is fast getting understood. A recent paper in the journal Neuroscience (T. Quarta et al, 2016, 341, 9-17) tries to implicate the mechanism by which the molecule dopamine triggers nerve cells in the brain and how it may differ from person to person, based on their genetics. Some of us want to have music played in the background while working and concentrating on it, while some others prefer silence; for the latter group, music in



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the background is a distraction. The above cited paper attempts to identify a relationship between genes and phenotypes in response to music.

#### **Music therapy**

That music can regulate mood and 'arousal' in everyday life and can be used to promote physical and psychological health has been known for quite some time. The neurochemistry of music is the title of a comprehensive and eminently readable review paper, published by Mona Lisa Chanda and Daniel J Levitin of McGill University, Montreal, Canada, in the journal Trends in Cognitive Sciences, in April 2013. Since this review is not freely downloadable on the web, let me quote a few sentences from their paper. They point out that music evokes a wide range of emotions in the human mind: "from exhilaration to relaxation, joy to sadness, fear to comfort and even combinations of these. Many people use music to regulate mood and arousal, much as they use caffeine or alcohol. Neurosurgeons use it to enhance concentration, armies to coordinate movements and increase cooperation, workers to improve attention and vigilance, and athletes to increase stamina and motion".

They further argue in this review that music influences our health through molecules and inter-cell connections that affect the brain neural circuitry in four major domains. These are (1) reward, motivation and pleasure (2) stress and arousal (3) immunity and (4) social affiliation.

#### **Like a drug**

When we experience music as thrilling, pleasing, peaceful or even provocative, a release of opium-like molecules have been detected, which trigger the brain circuitry in ways that offer pleasure and excitement.

The Montreal group says that pleasurable music activates the same neurochemical systems as cocaine does! Some forms of music can reduce stress and modulate arousal levels. These are generally 'relaxing music forms'- low pitch, slow tempo and no lyrics. Rhythm would be slow or not at all (as in meditative pieces). Such listening appears to reduce the levels of cortisone (a stress-reducing hormone) and norepinephrine (neurotransmitter). While stimulating music (army band march) produces an increase in heart rate and blood flow, relaxing music (meditative chants) reduces heart rate, pulse, blood pressure and so on.

#### **Affects immunity**

The third effect of music appears, surprisingly, to enhance immunity. Recreational music such as group singing or drumming has been studied and researchers found increased levels of the immunoglobulin A, a protein that acts against inflammation and infection. Western

researchers have claimed that listening to opera is anti-inflammatory. I wonder what the Indian equivalent music would be.

The fourth domain is the role of music in social affiliation. Group singing, march past to an anthem, dancing together are all examples. Studies on volunteers engaging in such group activities show higher levels of the two peptide hormones oxytocin and vasopressin. It is these two hormones that are involved in mother-child bonding, effective motivational states and so on. Duets - both in synchrony or 'sawal-jawab' type - are examples here.

These studies raise many other research questions. One of them is whether the effect of playing (or singing) music has the same effect as listening - active versus passive. And is music habit-forming as cocaine or alcohol is? How do we explain music therapy, or dance therapy? All these are exciting and challenging fields of medical and psychological research.

#### **Chennai team taps AI to read Indus Script**

The Indus script has long challenged epigraphists because of the difficulty in reading and classifying text and symbols on the artifacts. Now, a Chennai-based team of scientists has built a programme which eases the process.

Ronojoy Adhikari of The Institute of Mathematical Sciences and Satish Palaniappan, who is at Sri Sivasubramaniya Nadar College of Engineering, have developed a "deep-learning" algorithm that can read the Indus script from images of artefacts such as a seal or pottery that contain Indus writing.

Scanning the image, the algorithm smartly "recognises" the region of the image that contains the script, breaks it up into individual graphemes (the term in linguistics for the smallest unit of the script) and finally identifies these using data from a standard corpus. In linguistics the term corpus is used to describe a large collection of texts which, among other things, are used to carry out statistical analyses of languages.

The algorithms come under a class of artificial intelligence called "deep neural networks." "These have been a major part of the game-changing technology behind self-driving cars and Go-playing bots that surpass human performance," says Satish Palaniappan. The deep neural network mimics the working of the mammalian visual cortex, known as convolutional neural network (CNN), which breaks the field into overlapping regions. The features found in each region are hierarchically combined by the network to build a composite understanding of the whole picture.

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The process consists of three phases: In the first phase, the input images are broken into sub-images that contain graphemes only, by trimming out the areas that do not have graphemes. The grapheme-containing areas are further trimmed into single-grapheme pieces. Lastly, each of these single graphemes is classified to match one of the 417 symbols discovered so far in the Indus script.

#### **Indus script**

The Indus valley script is much older than the Prakrit and Tamil-Brahmi scripts. However, unlike the latter two, it has not yet been deciphered because a bilingual text has not yet been found.

A bilingual text has in many other cases aided archaeologists in understanding ancient scripts, for example, the Rosetta stone. This stone which was found in the eighteenth century carries inscriptions of a decree, issued in 196 BCE, in three parts, the first two in ancient Egyptian hieroglyphic and the Demotic scripts, while the bottom is in Ancient Greek. Since the decree was the same, the Rosetta stone provided the key to deciphering Hieroglyphs. For the lack of such a "Rosetta stone," the Indus script remains undeciphered today.

It is a major effort to even build a standard corpus of the language and decode the writing on existing artefacts and map them to this standard corpus. The most widely accepted corpora of Indus scripts was brought together by the efforts of Iravatham Mahadevan, noted Indian epigraphist, from the 3,700 texts and 417 unique signs collected so far.

When asked about the relevance of this work, Dr Mahadevan says, "It [the algorithm] represents a significant advance in the computerised study of the Indus Script. I wish I had this software 40 years ago when I compiled the Indus concordance."

#### **Turn to music to keep your brain fit**

Compared to earlier centuries, people live longer now. Longevity has steadily increased across the world, thanks to various health care efforts. This has also led to an increase in the incidence of age-related disorders, such as senile dementia. Today there are about 47 million people across the world affected by cognitive disorders such as Parkinson's, Alzheimer's and related disorders. We have about 4.1 million people across India affected by dementia, China is worse, with 9.2 million there.

An individual with dementia tends to have short-term memory loss, problems in movement of limbs, incoherent

speech and related problems. It is a cognitive disorder where the normal nerve circuitry in the brain has become distorted. Nerve fibres tend to get entangled (much like a cross connection or short circuit), protein molecules in the cells precipitate out of solution and form plaques, affecting nerve conduction. Part of the brain becomes dysfunctional. As of today, there are no effective drugs to treat and overcome Alzheimer's, Parkinson's and related disorders, though molecules such as L-Dopa offer some short-term relief. And it is well nigh impossible to take the brain out, correct the misconnection, do some rewiring and place the repaired brain back. Transplanting a brain is, of course, unthinkable, since it effectively means transplanting a person!

#### **Signs of hope**

Against this bleak picture, there are some hopeful signs. If we cannot remove errors and rewire, can we stop further damage, allow neighbouring nerve cells to do double duty and make up for what has been damaged? We know that this may be possible; for example when a finger is lost or amputated, the neighbouring brain areas take over the functions of that area of the brain which previously handled the amputated digit. In other words, the brain is not a static, stone-like entity but a plastic, remouldable one. If we can find ways to trigger such neuro-plasticity, we may be able to recover some of the lost functions, and hopefully delay any further damage to the brain circuitry. Remarkably, and gratifyingly, music is able to do so. We have now come to realize that music not only calms and comforts the mind but also can take on a therapeutic role. "Music Therapy is a non-pharmacological way, with a long history of use and a fine usability for dementia patients" write Dr David Calimag and colleagues in their paper 'Music Therapy is potential intervention for cognition of Alzheimer's disease: a mini-review', which has appeared in the journal *Translational Neurodegeneration* (2017) (DOI: 10.1186/s40035-017-0073-98).

That music plays a key role in cognitive development has long been known. We process music with almost every part of our brain. The baby in the womb feels the pulse of the mother, and likely even her humming in tune. Lullabies calm and comfort and teach the baby. While the oft-quoted claim that the IQ of children improves upon listening to Mozart needs solid scientific proof, it seems likely that not just listening, but training in music appears to foster cognitive development. The book 'Musicophilia: Tales of Music and the Brain' by the famous neurologist-writer Dr. Oliver Sacks points out that music is part of



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being human. And that many people with neurological damage learn to move better, remember more and even regain speech through listening to and playing music.

#### **Therapy for Alzheimer's**

This is the basis of music therapy. Dr. Concetta Tomaino, a music therapist, is reported to have played an old Yiddish song to an old man in the last stages of Alzheimer's, and after repeatedly listening to it for a month, he attempted to speak and sing it himself and resumed talking and moving about. Closer home, the renowned music therapist Mrs. Rajam Shankar of Secunderabad tells me that her singing the Raga Kalyani likewise activated a lady patient, who eventually started singing herself and slowly regained her activities. Readers will also enjoy the captivating award-winning film 'Alive Inside' which tells the stories of several dementia-afflicted patients and how music turned their lives around (available at <https://www.youtube.com/watch?v=6FwfV9pnj8o>).

Music therapy is a growing field, taught and practised in India and across the world. But it is important that appropriate and rigorous guidelines are drawn and certification done in order to separate the wheat from the chaff. It is also useful to analyse the reported individual cases where it has helped (and where it has not), and attempt to draw rational and empirical guidelines, particularly since it involves human subjects.

#### **Not without caveats**

Some caveats are in order. There are claims on the Web that raga X helps liver function, raga Y helps in diabetes, and so forth. These are over-claims, since music affects the brain and helps in cognition, not in curing metabolic disorders. Some others claim that some ragas are better than others for dementia. This too is a "one size fits all" claim. Music therapy is a deeply personal one, and depends on the mental condition, background and similar factors and thus is individual-specific. Also, is a song better or just chanting a note or even meditating - or a combination thereof? Here again, is it not better for the therapist to decide, based on the conditions of each specific patient?

#### **Flexing nanotech to prevent steel corrosion**

Turning to nanotechnology, a group of marine researchers from Kerala is attempting to combat corrosion of steel used for making fishing boats. Corrosion of steel has been a major cause of concern for the fishing sector of Kerala where steel vessels have almost replaced

wooden ones.

There is enhanced threat of corrosion in the case of welding joints and the hull of a vessel. The non-availability of good quality steel (BIS 2062 Grade B steel) as specified for boat-building has compounded the problem.

Scientists at the Central Institute of Fisheries Technology (CIFT), Kochi, have successfully tried applying nanomaterials like nano iron oxide, zinc oxide, cerium oxide and titanium oxides on steel surfaces under lab conditions. According to Dr. C.N. Ravishankar, director of the institute, these nanomaterials have high surface area and increased adhesiveness to the substrate. According to Dr. P. Muhammed Ashraf, Principal Scientist at CIFT, who led the research programme, the boat-building steel was coated with nano-trimetal oxide mixtures, and its evaluation in laboratory showed about 40% corrosion inhibition under marine environments. He said that the coating also exhibited healing stress at a faster rate.

Conventional methods of coating of steel materials with ceramic, polymeric and electro-deposition are effective only to a limited extent. Corrosion-protection methodologies usually employ organic or inorganic-based coatings on steel. The researchers pointed out that the major disadvantages shown by these coatings are poor adhesion, coating defects, poor scratch resistance, optical transparency, low coating flexibility and vulnerability to abrasion. Even the recently introduced nanomaterial-incorporated polymer coatings have their own set of challenges — they tend to develop pinholes and pores, which could lead to the penetration of corrosive agents into the matrix followed by corrosion.

#### **ICHR to study if Ram Setu is man-made or natural**

The Indian Council of Historical Research (ICHR) is set to undertake an archaeological exploration to find out whether the Ram Setu is a natural or man-made phenomenon.

It will undertake the exploration in October and November, before deciding whether a detailed underwater archaeological excavation is required to probe deeper, said ICHR chairman Y. Sudershan Rao.

Also known as Adam's Bridge, Ram Setu is a stretch of limestone shoals running from Pamban Island near Rameswaram in Tamil Nadu to the Mannar Island near the northern coast of Sri Lanka. While there are geological theories on its natural formation, many Hindus believe it was built by the army of Lord Ram to go to Lanka to



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wage war with its king, Ravana.

"In October and November, we will try to figure out whether more is required on this. We will also publish our findings," Professor Rao told journalists.

The ICHR linked the excavation to a two-week session on ocean archaeology it will hold in May or June. Professor Alok Tripathi of Assam University at Silchar is being roped in to impart training to 15-20 researchers into theoretical aspects of ocean archaeology. After the training, the researchers will be roped in to undertake the excavation of Ram Setu.

The plan for a Sethusamudram shipping canal project to cut travel time for ships — as they could not cross the shallow Ram Sethu otherwise — is hanging fire as both Hindu groups and environmentalists have opposed it.

### Flexing nanotech to prevent steel corrosion

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### Scientist says international journal violated ethics on Bihar's 'litchi disease' report

The scientist who investigated the mystery disease that proved fatal for many 15-year old children in Muzaffarpur, Bihar at the instance of the State government has raised ethics issues about the way the research has been published by the journal *Lancet Global Health* on January 30. "Not giving due credit for work done by others is not acceptable in science," Dr. T. Jacob John, a virologist who was earlier attached to the Christian Medical College, (CMC) Vellore says.

"They quote our study but don't honestly say what we have found. If they did that then they can't claim originality. They have done a large case-control study but borrowed all important information connected with the illness from us," he argues.

Dr. John published in 2014 evidence of a link between a fruit in Jamaica, the ackee, from the same family as litchi, and a disease called acute encephalopathy in Jamaicans. He showed the close clinical similarity between ackee poisoning and the Muzaffarpur illness, where litchi consumption and skipping the evening meal could result in very low blood glucose and acute encephalopathy, leading to seizures and coma, and death in many cases.

### Authors refute claim

The *Lancet* authors, however, refute this. "We have acknowledged and cited all three of Dr. John and his colleagues' papers in *Current Science*," Dr. Padmini Srikanthiah at CDC Atlanta and the corresponding author said in





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an email. "There are a few key findings in our study that have not been, to our knowledge, reported previously. First: the evidence of the metabolites of hypoglycin A and methylenecyclopropylglycine (MCPG) in the specimens of affected children, and the demonstrated metabolic abnormalities that resulted due to the effects of these toxins. And, second, a statistically significant epidemiological association between illness and litchi consumption, as well as the modifying effect of the absence of an evening meal."

Dr. John's team had in a May 2014 paper in Current Science pointed out that the illness was due to non-infectious encephalopathy and not viral encephalitis as was widely suspected. That it was a form of encephalopathy associated with low blood sugar was again emphasised in a August 2014 paper in Current Science.

A December 2015 Current Science paper reported presence of MCPG in litchi; but not MCPG or hypoglycin A in samples of children. But the study strongly suggested the role of MCPG.

"Our finding provides the much needed evidence for biological plausibility that litchi consumption by undernourished children, especially after prolonged fasting, triggers the hypoglycaemic encephalopathy," early in the morning, the paper says.

### 'How can you partition the air?'

Having seen decaying corpses line the lanes of Old Delhi as a child and his home becoming a "refugee camp" in 1947, lyricist and filmmaker Gulzar had one message for Indians and Pakistanis when he spoke at the Partition Museum here: Lands, roads, and countries could be partitioned, but not language and culture.

"How can you partition the air?" he asked rhetorically, at which the audience smiled and nodded as the midday sun streamed into the old Town Hall that houses the museum.

The noted poet has written extensively on the Partition over the years. But at an interactive session that kicked off the Arts and Literature Festival of Amritsar, he reminded the audience to "remember". To prevent the spread of hatred and revenge, both countries had tried to suppress the memories of 1947, he said. "It's time to take out these memories and display them on the walls, like here at the museum," he said, adding that both India and Pakistan had not allowed any films to be made on the Partition.

#### **The same roots**

Sharing his own experiences as a child and then dec-

ades later being mistaken for a long-lost son by a Union Minister who had lost two children during the Partition, Gulzar emphasised the similarities between the two countries. "The roots, music, tehzeeb and zaban are the same," he said, before suggesting that materials from Pakistan should also be included in the exhibits at the Partition Museum.

"A country is not its government. Governments will come and go, but the people will remain," he said.

The museum, which is the first one in the world dedicated to preserving memories of the Partition, opened with an exhibition on October 24, 2016 and has seen about 30,000 visitors since then, its CEO, Mallika Ahluwalia, told The Hindu. From maps depicting the proposed boundaries of Punjab to oral histories of those who were affected, the items stored at the museum document the weeks leading up to August 15, 1947, and its aftermath. Photos, newspaper reports, personal effects, paintings and audio-visual displays make up the museum. One of the displays is a saree with phulkari embroidery that belonged to someone affected by Partition.

Ms. Ahluwalia said that a room dedicated to recording oral histories and an events space would be added.

Additional Solicitor General and BJP leader Pinky Anand, who is a trustee of the museum, said that the Centre would look into facilitating talks with counterparts in Pakistan to collect material for the exhibit.

"Partition was not a one-way affair," she said.

### Archaeologists discover new Dead Sea Scrolls cave

Archaeologists have uncovered a new cave that once housed Dead Sea Scrolls, in a discovery described as one of the "most important" in 60 years.

The Hebrew University in Jerusalem said the scrolls were missing from the cave, though, but hopes to find other caves. The excavators, including Oren Gutfeld and Ahiaad Ovadia from the Hebrew University, are the first in over 60 years to discover a new scroll cave and to properly excavate it.

The Dead Sea Scrolls, which include the oldest known manuscripts of the Hebrew Bible, date from the 3rd century BCE to the 1st century CE.

About 900 scrolls were discovered between 1947 and 1956 in the Qumran caves above the Dead Sea, archaeologists said.

#### **Biblical texts**

The parchment and papyrus scrolls contain Hebrew,



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Greek and Aramaic writing, and include several of the earliest-known texts from the Bible, including the oldest surviving copy of the Ten Commandments.

The most recent scrolls date to around 70 CE, when Roman troops destroyed the temple.

“This discovery of a 12th cave could revolutionise the information we have on the Dead Sea Scrolls,” Hebrew University archaeologist Oren Gutfeld said, calling it one of the “most important” discoveries since 1956.

The cave discovered west of Qumran in the occupied West Bank contained no manuscripts, but there is ample evidence of their earlier presence.

This includes fragments of pottery in which they were placed and the leather straps, Mr. Gutfeld said. Many of the caves containing the manuscripts were looted in the 1950s.

Heads of pickaxes dating from that time were found in the cave in another indication they had been looted, a Hebrew University statement said.

“We hope to find other caves containing or having contained manuscripts as part of the operation launched by the Antiquities Authority to carry out systematic excavations in the caves of the Judean Desert (where the Dead Sea is located),” Mr. Gutfeld added.

Many experts believe the manuscripts of the Dead Sea were written by the Essenes, a dissident Jewish sect that had retreated into the desert.

Other scholars believe they came from libraries of the Second Jewish Temple in Jerusalem and private libraries sheltered in caves.

The artefacts are mostly housed at the Israel Museum in Jerusalem, where some of the larger pieces are shown at the dimly lit Shrine of the Book.

The Shrine’s white ceramic dome recalls the lid of the jars in which the manuscripts were uncovered.

“The important discovery of another scroll cave attests to the fact that a lot of work remains to be done in the Judean Desert and finds of huge importance are still waiting to be discovered,” said Israel Hasson, Director-General of the Israel Antiquities Authority.

“We are in a race against time as antiquities thieves steal heritage assets worldwide for financial gain,” Mr. Hasson said.

### SCIENCE-GRAPHENE

In a breakthrough, scientists in Melbourne have used the humble soybean to make the world’s strongest material graphene commercially more viable.

Graphene is a carbon material that is one atom thick.

Scientists at Commonwealth Scientific and Industrial Research Organisation (CSIRO) in Australia have developed a novel “GraphAir” technology that grows graphene film in ambient air with a natural precursor, making its production faster and simpler. “This ambient-air process for graphene fabrication is fast, simple, safe, potentially scalable, and integration friendly,” CSIRO scientist Zhao Jun Han, said.PTI

### ‘India, a lab to learn about what works in development’

World Bank Chief Executive Officer Kristalina Georgieva has described India as a “laboratory”, for the world to learn about what works in development and to find new ways to collaborate.

Ms. Georgieva, who is in India on her first official visit, said in a statement: “India is our biggest middle income client. Its economic growth influences global growth. Its achievements in health and education contribute to the world achieving the Sustainable Development Goals.”

“I am keen to learn more as India is a laboratory for the world to learn about what works in development and to find new ways to collaborate,” she added.

While on a visit to Pakistan in January, Ms. Georgieva said she had “constructive discussions” with that country’s leadership on the Indus Waters Treaty.

India, Pakistan and the World Bank are signatories to the Treaty and are in discussions on resolving disagreements the two countries have over India’s construction of two hydroelectric power plants.

Maintaining its neutrality as a signatory, the Bank had announced a pause in the separate processes initiated by India and Pakistan under the Treaty to allow the two nations to resolve their disagreements amicably.