SCIENCE AND TECH.

THE CRUX OF THE HINDU

Vol. 15

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Science and Tech.
The Crux of The Hindu
Vol. 15
News for Jul-Sep 2018

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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After the success of our monthly magazine The Crux of The Hindu and PIB, we are introducing a new and convenient product, to help the aspirants for various public services examinations. Today, the knowledge of the Current Affairs (Science and Technology) constitutes an indispensable tool for all the recruitment examinations. However, as per the examinations are concerned, it is quite tedious task to memorise each and every news. Moreover, every news as given in magazines and newspapers may or may not be relevant

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Best Wishes

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Science and Tech. The Crux of The Hindu

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IFFCO rolls out portal for farmers

Fertiliser major IFFCO has partnered with Singapore-based technology firm iMandi to start an e-commerce platform for farmers, with an investment of about Rs. 80 crore.

An e-commerce app, 'IFFCO iMandi', has been introduced and would cater to 5.5 crore farmers already associated with the cooperative. A web portal has also been developed.

IFFCO's subsidiary IFFCO eBazar Ltd has taken 26% stake in iMandi Pte Ltd.

"[The app] is a 'one stop shop' for agri inputs and produce, FMCG, electronics, loans, insurance etc," IFFCO managing director U.S. Awasthi said.

Scientists decode how mustard plants tolerate salt

High salinity is one of the major problems in agricultural fields and many countries, including India, use an organic sulphur compound thiourea to minimise the negative effect of salt stress. Now, using molecular biology tools, scientists from Bhabha Atomic Research Centre (BARC), Mumbai have reported how this treatment altered the plant RNA and hormones to facilitate this survival in mustard plants grown with high salt stress (125-150 milliMolar NaCl).

Anthropogenic factors, irregular irrigation and proximity to the sea can cause high salinity in the agricultural fields and this induces redox imbalance and damages the plant. Various studies have shown that thiourea is a good redox stabiliser as it scavenges multiple reactive oxygen species including hydrogen peroxide. The researchers carried out studies to understand how this thiourea activates the tolerance mechanisms.

Mustard seedlings, just 20-day-old plants, grown in a liquid nutrient medium, were given saline treatment with and without thiourea, and their growth was studied for seven days. The plants which were supplemented with 75 micromolar of thiourea showed increased survival and better phenotype with larger leaves compared with the group grown in saline medium.

The researchers then studied the microRNA of the plant as it is an important component that regulates plant transcriptomes according to the environmental conditions.

"We found that downregulated microRNAs were enriched in the thiourea group to facilitate transcriptional activation and adaptation under salt stress conditions," explains Dr. Ashish Kumar Srivastava, at BARC and first author of the paper published in Scientific Reports.

They also studied different genes and plant hormones that are involved in stress management and identified four key genes responsible for the adaptation. Plant hormones such as ABA, Auxins, jasmonates which have been shown to play important roles in salt tolerance were all found to be co-ordinately regulated upon thiourea treatment.

The team also studied the effect on spraying diluted thiourea directly on the shoot of rice plants grown in arsenic contaminated soil and found it effective in reducing arsenic accumulation in rice grains.

Further studies are underway to validate the effects of thiourea in rice and multiple different crops under varied environmental conditions.

"Thiourea based technology can sprovide easy-cum-affordable solution to the farmers for minimizing abiotic stress induced losses in crop plants," explains Dr. Penna Suprasanna at BARC one of the authors of the paper.

The lowdown on kharif sowing

What is it? Why does it matter? What does it mean? What next?

With the summer (kharif) sowing picking up across the country on account of improved distribution of monsoon rain during the last fortnight of August, another bumper harvest is expected this season, if weather conditions continue to be conducive. While the increase in crop acreage has eased the fear of a fall in grain production, the bright harvest outlook also throws a challenge to the government to deal with a situation of abundance of produce. A good kharif harvest means an increase in supply, which could result in a drop in crop prices, hitting farm income.

Agriculture and Farmers' Welfare Secretary S.K. Pattanayak, anticipating a good harvest, recently pointed out that the challenge with a "situation of abundance" before the government is that of maintaining food prices at levels that ensure farmers get their due profits, while not depriving consumers of the gains of a bumper harvest.

This year, summer crops have been sown on nearly 1,053 lakh hectares against 1,046 lakh hectares during the corresponding period in 2017-18, as per data released by the Agriculture Ministry on September 14. Though the cumulative monsoon rain across the country has been 8% lower than the normal as of September 14, the higher acreage is being attributed to better distribution of rainfall. The National Collateral Management Services, a private post-harvest management company, last week released its second advanced estimates for the 2018-19 kharif crop. It has pegged the total grain production at 136.75 million tonnes. The estimate is just 3% less than previous year's record harvest of 140.73 million tonnes.

A bumper harvest will help the government fill its granaries for the Public Distribution System and reduce hunger and malnutrition. However, with the increased supply of crops (cereals and pulses) other than the foodgrain, which are procured by the government, the fall in prices can never be ruled out, which is associated with the economics of demand and supply. A bumper crop is expected to benefit the consumer. For farmers, it is a different story. The key issue is that a very small proportion of the produce is procured by government agencies. The bulk of the output is purchased by private players. The system of selling the produce is such that the intermediary gains more and the producer and the consumer both suffer. While the primary producer (farmer) gets low prices, consumers often have to pay high rates.

After harvesting, the crop goes out of the hand of the primary producer (farmer) and is largely usurped by the intermediary. When the primary producer's share of the pie is declining, the sustainability of farmers come under threat. This is the trend with bumper crop prices, especially those of pulses, vegetables and fruits, crashing at the time of harvest and sky-rocketing in the lean period. Marketing institutions are very weak across the country, and innovative reforms are lacking in this area.

Farmers' organisations have come together to demand a better deal for primary producers, as their survival is at stake. Lakhwinder Singh, an agriculture expert and professor of economics at Punjabi University, Patiala, points out that a large number of small and marginal farmers are becoming highly distressed owing to the system of market institutions squeezing them both on the input and output side. "The interlinked transactions, such as the informal credit market, further make them victims of a debt trap. Largescale suicides of farmers across India are testimony to this. To make farming a healthy business, the government needs to invest in the agriculture sector to improve input and output chains, where the value addition should be reaped by the primary producer [farmer]," he says.

Increased investment is urgently required to revamp a dying agriculture sector and make it inclusive and sustainable in the long run.

Sugarcane, paddy a hit this kharif

The biggest increases in acreage this kharif season come from water guzzling crops such as sugarcane and paddy. More resilient crops such as nutri-cereals — ragi, jowar, bajra — have dropped in acreage this year, Agriculture Ministry data reveals.

As on September 20, paddy has been planted over 2.5% more area than usual for the corresponding week. Sugarcane acreage is up a whopping 12% from the norm. On the other hand, the acreage of nutri-cereals has dropped 4.3%, despite the government increasing the MSP for these millets and allowing their inclusion in the Public Distribution System. The acreage of pulses has risen 16% compared to the average over the past five years, but has actually dropped by more than a percent from last year's acreage.

Ashok Gulati, Infosys Chair Professor for Agriculture at ICRIER, pointed out that all sugarcane and a large chunk of the paddy harvest are procured by the government or bought at government-mandated prices. "So farmers' market risk is covered."

Record kharif foodgrains production expected

India's food grains production is estimated at a record 141.59 million tonnes (MT) in the kharif season of 2018-19 crop year, Agriculture Minister Radha Mohan Singh said.

The country had produced 140.73 MT food grains in the kharif season of 2017-18 crop years (July-June).

The Minister released the first advance estimates of foodgrains production for kharif (summer-sown) season for 2018-19 crop years.

"The country witnesses foodgrain production estimated at 141.59 MT, an increase of 11.94 MT against 129.65 MT average productions during 2012-17," Mr. Singh tweeted.

Accordong to the data shared by the Minister, rice output is estimated at a record 99.24 MT, oilseeds 22.19 MT, maize 21.47 MT and sugarcane 383.89 MT.

Rice production stood at 97.5 MT in last year's kharif season, while oilseeds output was 20.99 MT. The sugarcane production stood at 376.9 MT.

The sowing operation of kharif crops begins with the onset of monsoon and harvesting starts from mid-September. Paddy, maize and soyabean are major kharif crops.

Atomic Energy

IISc duo's claim of ambient superconductivity may have support in theory

In July, a two member team of chemists, Anshu Pandey and Devesh Kumar Thapa, posted a preprint on the arXiv server claiming to have observed superconductivity at ambient temperature and pressure in samples in their lab in the Solid State and Structural Chemistry Unit at Indian Institute of Science, Bengaluru. They had studied materials with silver nanoparticles embedded in a gold matrix and found that their samples showed the signs of becoming a superconductor on cooling below 236 K (-37 degrees Celsius). Further, when they altered the mole fraction of gold in the samples, they could bring up the critical temperature Tc (the temperature at which the transition to superconductivity happens) up to room temperature.

They found the two effects that are the considered the signatures of superconductivity — resistance dropping close to zero below the critical temperature and the expulsion of magnetic flux from within the material — which often shows up as magnetic levitation at the superconducting temperature. The possible applications of such a discovery are unimaginably vast — a material that conducts electricity without resistance, or loss of power at room temperature. Magnetic levitation has also been discussed in the context of mag-lev trains etc.

Query raised

However, soon after the preprint was posted, there was a query raised by Brian Skinner, MIT physicist on two counts. One stemmed from his scepticism that a gold-silver combination could become a superconductor at all – because monovalent metals like gold and silver are by themselves never seen to become superconducting even at low temperatures. It is broadly believed in the physics community that they cannot ever exhibit superconductivity. The other objection was stunning — Dr Skinner's analysis of the graphs plotted by Thapa and Pandey showed that the noise factor was too similar in two of the curves. Noise, being a random factor, cannot be similar for different trials, was his contention.

Amid this controversy, the IISc team chose to remain silent, only assuring Dr. Skinner in an email that they were studying the strange noise correlation.

But as to the unusual behaviour of gold-silver complex, G Baskaran, a Distinguished Fellow of The Institute of Mathematical Sciences, Chennai, is not surprised. He suggests that even though gold and silver are not themselves capable of superconductivity, the combination can have different properties. "The material can house strong perturbations that can liberate a confined, or latent, superconductivity," he says.

According to him, even in isolation, there are many possible phases, including different types of superconducting phases, in which monovalent metals like gold, silver, copper etc can exist in principle. However, these phases do not manifest themselves in either calculation or direct experiments, and he believes this is because they are drowned out by competing quantum phases.

In fact, Prof. Baskaran includes in this list alkali metals such as sodium, potassium and others that have a similar electronic structure. (None of these, except for lithium, exhibits superconducting phases, even at very low temperatures.) Though in early days scientists tried to explain this, it is now accepted by most that these can never be superconducting. "Good metals make bad superconductors," being the dictum.

Hubbard model

To overthrow this dictum, Baskaran invokes the Hubbard model, which is a theoretical model that describes the energetics of the system —monovalent metals. As he puts it, "different parts of the model exhibit superconductivity, but as a whole does not". Thus, there may be different possibilities open. Some such latent phases that have been discussed earlier include charge-density waves and spin-density waves. To this list, he includes several types of superconducting phases. Unlike in the pure metals, in composite material, the balance may tip in favour of superconductivity.

In the case of the Pandey-Thapa results, he says: "They have put silver nanoparticles into gold. Given the chemistry of the two metals, silver being more electronegative, will donate the electrons into the gold matrix, making for strong perturbations to the individual energetics." This appears to be pushing the combination into a superconducting phase. He further adds that the lattice structure of the silver nanoparticles may be different from the regular face-centred cubic array that silver enjoys in the bulk, which may add to the effect.

According to Prof Baskaran, such effects can be seen in any combination of the eight monovalent metals he has named – sodium, potassium, lithium, and rubidium, cesium, gold, silver and copper. "Perhaps not all combinations may be practically possible, owing to their solid state chemistry, but some at least, which has the right perturbations, should show interesting behaviour," he clarifies.

JNCASR: A new, robust form of gold

Researchers from Jawaharlal Nehru Centre for Advanced Scientific Research (JNCASR), Bengaluru, have developed a new type of gold in the form of very small crystals — microcrystallites. The microcrystal gold has been found to be nobler than gold — it do not dissolve in mercury and Aqua regia (a mixture of nitric acid and hydrochloric acid), and showed the least interaction with copper.

The microcrystallites were synthesised by decomposing an organic complex containing gold and other ions under controlled conditions. The newly formed microcrystallites, about 3 micrometre in length were found to be of a different crystal structure. Normal gold has a (face-centered) cubic structure, while the new ones exhibit deformed cubic structure — tetragonal and orthorhombic cells.

Copper growth

The researchers then examined copper growth on these gold crystals when subjected to plating without the use of electrodes. Electron microscopy images revealed that thick copper got deposited on normal gold within minutes, while no detectable copper was seen on the central portion of the new crystals even after an hour. "We found deposition of copper only on the tips of the new crystallites while the rest of the crystal surface was devoid of copper. This may be due to the different arrangement of the new facets," explains Chaitali Sow, Ph.D student at JNCASR and one of the authors of the paper published recently in Angewandte Chemie.

The researchers then investigated the stability of the gold microcrystallites using corrosive agents like mercury and Aqua regia. While normal gold disappeared in a matter of minutes when immersed in mercury and also in aqua regia, the gold crystallites remained intact. Microscopy imaging showed that the surface was undamaged.

"All these properties make our new crystallites an ideal candidate for catalytic purposes. Gold in itself is not a catalyst but the new gold microcrystallites have very active surfaces. Compared with other catalysts like palladium and ruthenium, gold is cheaper and it can also be easily

recovered," explains Prof. Giridhar U. Kulkarni, Director at the Centre for Nano and Soft Matter Sciences (CeNS), Bengaluru and corresponding author of the paper. "Though the production cost of the crystallites is a little high, we are optimising it to bring down the cost. More studies are needed to understand them fully in the context wide range of applications in the offing," he added.

Helium is now 150

On August 18, 1868, helium was discovered by astronomers studying the sun during a total solar eclipse. The site of this discovery was none other than the Andhra coast. It is the only element to have been seen in the sun before it was known to exist on earth.

Identifying helium was key in usherring in a new era in astronomy, namely astrophysics. "Sitting here on Earth, and by analysing nothing more than the spectrum of light, we can now determine the chemical compositions of stars and gas far far away, and even calculate their temperature and density," says Niruj Mohan Ramanujam. A member of the Public Outreach and Education Committee of the Astronomical Society of India, Dr Ramanujam gave a talk on the occasion at The Institute of Mathematical Sciences, Chennai.

Astronomers do this analysis routinely now, but the story of how this came about is intimately linked with an eclipse that was seen in Andhra Pradesh exactly 150 years ago.

Dr Biman Nath, an astrophysicist from Raman Research Institute, Bengaluru, describes this discovery in his book, The Story of Helium and the Birth of Astrophysics. On August 18, 1868, astronomers across the globe geared up to watch the solar eclipse in its path of totality. Those from the Royal Astronomical Society led by Major James Francis Tennant, and French astronomer Pierre Jules Janssen, chased the eclipse to Guntur. The Government Astronomer of the Madras Observatory, Norman Robert Pogson and his team watched the eclipse from Machilipatnam.

Their aim was to study the corona, the outer layer of the sun, which is only visible during a total solar eclipse, and confirms a proposition put forth by Gustav Kirchoff and Robert Bunsen – that all materials radiate light of a characteristic colour when they are hot.

While the astronomers did confirm this hypothesis, it was Pogson who had a hunch that the bright yellow line they saw in the sun's spectrum was not due to the presence of sodium, known for its yellow flame, in the sun's atmosphere, but a hitherto unknown element. This was confirmed by

Joseph Norman Lockyer, who also gave it the name of helium – as helios refers to the sun. It was only in 1895, more than 25 years later, that helium was isolated in the lab by William Ramsey.

The site of the Madras Observatory now houses the Nungambakkam Meteorological Observatory, and Norman Pogson, discoverer of helium, died in 1891 and is buried at St George's Cathedral, Chennai.

Fuel from air and water

As we have kept on burning more and more of organic fuel, such as coal and crude oil, over the last century across the world, the amount of the oxidation product, carbon dioxide (CO_2), in the atmosphere has reached alarming levels, causing global warming and climate change.

Given this scenario, why not capture the CO_2 from the atmosphere and convert it into something inescapable, such as solid carbonate rocks? Such direct air capture (abbreviated as DAC) of the gas and converting it from the biosphere (obtained from biological sources such as burning fuel by us) to the geosphere (as rocks and minerals) has been done by a company in Switzerland, called Climeworks. They have put up a plant in Iceland, where they bury CO_2 (or sequester it) into solid calcium carbonate ($CaCO_3$) rocks, just as basalt; they also sell the CO_2 to greenhouses and beverage makers.

An even better method would be to convert it back into hydrocarbon fuel through a reverse reaction, a process termed as air to fuel or A2F. And a group of scientists led by Dr David Keith of Harvard have put together a company called "Carbon Engineering", with such a conversion of DAC into A2F. They have published their latest paper in the journal Joule last month (see Keith D, et al., A Process for Capturing CO_2 from the Atmosphere, Joule, DOI: 10.1016/j.joule.2018.05.006). Incidentally, the name of the journal is apt since a unit of energy in the international system of units is a joule, named after the English physicist James P. Joule).

The team has been working for the last several years on this problem. What is being done is to capture the undesirable product CO_2, run it through a reactor in an efficient manner and use it to combine with hydrogen (obtained through electrolysis of water) and generate the hydrocarbon fuel. The whole process is what is termed as 'carbon-neutral-fuel production' by them.

Capturing CO_2 from ambient air itself is not new. As the authors point out, this was attempted as early as the 1950s, as a pre-treatment of air; and in the 1960s, it was attempted to use as feedstock for the production of hydrocarbon fuels in mobile nuclear power plants. What Carbon

Engineering has done is to describe the nuts and bolts of the process, the engineering steps, and the cost-benefit analysis. Their claim is that it should be possible to make the process as viable as anywhere between US $50-100 per ton of CO2 captured by DAC.

As Tracy Staedter summarises it in her "Inscience" column of June 2018, "ambient air is sucked in, passed over a thin plastic surface that has a solution of potassium hydroxide (KOH). The potassium carbonate (K2CO3) so obtained is piped into a reactor containing calcium hydroxide (Ca(OH)2), to make pellets of calcium carbonate (CaCO3). The KOH released in this reaction is re-circulated for use. Now the pellets are heated, releasing CO2 which can be sequestered (as Climeworks have done), or can be mixed with hydrogen (H2, obtained separately through electrolysis of water), to make a hydrocarbon fuel. The company should be able to make fuels for vehicles, using their approach".

Dr. David Roberts, in his analysis of this A2F project, in his website (vox.com) also considers the approach of Carbon Engineering to become viable in the near future. And Dr. Jeff Tollefson writes about A2F in the 7 June 2018 issue of Naturethat DAC is cheaper than what scientists had thought. It used to be thought that it would cost anywhere between $50 to $1000 per ton of CO2. Now it appears to be anywhere between $94 and $234. And 1 million tons of CO2 can be converted to about 30 million gallons of jet fuel, diesel or gas.

The interesting points to note in the above chemical reaction cycle are: CO2 is pumped in step1 and comes out in step 3, where it can be captured and stored for making fuel by reacting with hydrogen in a separate reactor. Water which is a reagent in step 4 is a product in step 2. And Ca(OH)2, a reagent in step 2 is released in step 4. Thus the whole process is not just carbon-neutral but appears to be inorganic-chemical-neutral as well. It is estimated that 1 million tons of CO2 can be converted to 30 million gallons of jet fuel diesel, or gas.

This is reverse engineering at its most hopeful. Or as the wag said: whatever goes up should come down!

IISER Bhopal develops organic solar cell using vitamin B12 derivative

Researchers at the Indian Institute of Science Education and Research (IISER) Bhopal have developed cheaper and more flexible organic solar cells using a synthetic derivative of vitamin B12.

An organic solar cell is made up of acceptor and donor materials. The donor absorbs light from solar radiation and the harvested energy is passed to the electrodes with the help of the acceptor. In the present study, published in ACS Applied Materials and Interfaces, the researchers synthesised the donor using an artificial aromatic chemical (corrole) which has a similar structure to the corrin ring in vitamin B12. The artificially synthesised corrole (Cor-BODIPY) absorbs light much like porphyrin in natural chlorophyll.

"Corroles have very good photophysical properties. They show excellent absorption in the visible light range and are highly stable. They are very flexible unlike the silicon solar cells and so could be used in flexible electronics," says Dr. Jeyaraman Sankar from the institute and corresponding author of the work.

Another commercially available organic molecule was used as an acceptor. "The molecule is electron deficient and so can be used as an acceptor, while the corrole is the electron source. We carried out light absorption and emission studies," says Dr. Ruchika Mishra, Research Associate at the institute and the first author of the paper.

The organic cells developed by the team showed three absorption bands between 400-650 nm — whole visible range of the solar spectrum — with a maximum absorption at 420 nm. The ability to turn the light absorbed to electricity (power conversion efficiency) was 2.5%.

The researchers enhanced the performance of the solar cells by coating them with different solvents. The surface morphology was investigated after the treatment and microscopy images showed that the treatment helped improve the alignment of the Cor-BODIPY donor by forming a denser molecular packing on the active surface. This treatment more than doubled the power conversion efficiency from 2.5% to 6.6%.

"Many solar cells made of porphyrins which started with 1% efficiency have now reached over 10% due to appropriate improvements. Further optimisation can help increase the efficiency of our cells too. More studies are also being carried out to ascertain its stability and the results look promising," adds Ruchika.

Corroles are currently used as sensors, catalysts and in biomedical imaging. This is the first study wherein a corrole has been utilised for a bulk heterojunction solar cell as a donor material. The authors hope that this study shall open up a new window and may pave way for its development as a low-cost, efficient photovoltaic material with a wide range of absorption and increased flexibility.

New battery may help cut carbon emissions

Researchers at Massachusetts Institute of Technology (MIT) have developed a new battery made partly from carbon dioxide captured from power plants. While still based on early-stage research and far from commercial deployment, this battery could continuously convert carbon dioxide into a solid mineral carbonate as it discharges, said the study published in the journal Joule.

The researchers believe that the new battery formulation could help reduce the emission of the greenhouse gas into the atmosphere.

The battery is made from lithium metal, carbon and a novel electrolyte.

In lithium–carbon-dioxide batteries, which use the gas as a reactant during discharge, the low reactivity of carbon dioxide has typically required the use of metal catalysts.

These remain expensive, poorly understood, and the reactions are difficult to control.

By incorporating the gas in a liquid state, however, Betar Gallant, Assistant Professor at MIT, and her coworkers found a way to achieve electrochemical carbon dioxide conversion using only a carbon electrode.

The key is to pre-activate the carbon dioxide by incorporating it into an amine solution, the study said.

“Aqueous amines and non-aqueous battery electrolytes are not normally used together, but we found their combination imparts new and interesting behaviours that can increase the discharge voltage and allow for sustained conversion,” Dr Gallant added.

ISRO awaits advanced materials

A national effort is needed to develop and produce advanced and exotic materials to drive the future space programme, Indian Space Research Organisation (ISRO) Chairman K. Sivan has said.

Along with high propulsion systems for its launch vehicles, the ISRO is pursuing materials that have extraordinary properties, such as aluminium and beryllium alloys and carbon nanotubes. These are needed for the upcoming high-profile national missions such as the Human Space Programme (HSP), the Reusable Launch Vehicle (RLV), re-entering crew capsules, fuel-saving scramjet missions and the distant single-stage launchers. Locally made materials will also help to cut imports and also lower mission costs, Dr. Sivan said here.

He was delivering the 37th annual Brahm Prakash memorial lecture organised by the Indian Institute of Metals and the Indian Institute of Science. Brahm Prakash was a renowned metallurgist and former director of ISRO's Vikram Sarabhai Space Centre, Thiruvananthapuram, in the 1970s.

"In recent years, ISRO has indigenised a large number of materials that are hard to get. This has reduced the import content from around 32% to 8% now. However, development of advanced materials such as carbon carbon composites and those for electronics is the immediate need of the space programme. A national effort is required in these two areas," Dr. Sivan said.

"Lab-level R&D can produce small quantities of special materials. We want industry to come forward to produce them in large quantities," Dr. Sivan later told this newspaper.

Biotechnology

Bacteria develop resistance even without exposure to antibiotics

The environment where bacteria such as E. coli thrive can be complex with different stresses being present at the same time and changing unpredictably at different time scales — daily or seasonal. Researchers at Pune's Indian Institute of Science Education and Research (IISER) found exciting results when they replicated these conditions in the lab — E. coli developed resistance to antibiotics and heavy metals even when the bacteria were not exposed to them.

Study design

When exposed to a combination of stresses — salt, pH and oxidative stress — that varied unpredictably on a daily basis, E. coli did not show statistically significant adaptability at the end of 30 days (170 generations). But bacteria did show improved fitness and better growth rate at the end of 100 days. Thirty days produce 170 generations of E. coli while 100 days produce 900 generations.

To make the environment complex, the researchers led by Sutirth Dey from IISER Pune's Biology Division exposed the bacteria to one or two factors (says pH and salt) that were kept normal while one or two factors were abnormal and caused stress. Unpredictability was brought in by randomly changing the three factors that caused stress on a daily basis. Totally, 30

combinations that make the environment complex and unpredictable were used for the study.

"At the end of 30 days when compared with ancestors [or controls], the bacteria exposed to complex, unpredictable environment did not develop statistically significant advantage in terms of improved fitness," says Shraddha Karve from IISER Pune's Biology Division and first author of a paper published in theJournal of Evolutionary Biology.

Surprise finding

"But what came as a surprise was that the bacteria evolved the ability to tolerate novel stresses that they were not exposed to, such as antibiotics (norfloxacin) and heavy metals (cobalt and zinc)," says Dr. Karve. "We repeated the experiment all over again as the result was so surprising, and we got the same outcome."

Another study in the Journal of Biosciences by the team confirmed that efflux pumps in bacteria show greater efficiency in throwing out antibiotics from inside (the bacteria) though they have not been able to precisely find out why and how the exposure to complex, unpredictable environment causes this.

The researchers also studied resistance at the population level. The bacteria that have already been exposed to 30 days of stress (pH, salt and oxidative stress) were then exposed to antibiotics or heavy metals. The whole population showed better growth rate than controls and could better resist antibiotics and heavy metal stress.

"What we found was that the bacteria had much better efflux efficiency than the ancestors [controls]. It could be that during the 30 days of evolution the efflux pumps had greatly evolved either by working continuously or by becoming more efficient," she says.

"Once the efflux pumps' efficiency has been increased by exposure to other stresses, the ability to resist multiple drugs is only to be expected," adds Prof. Dey.

Implications for public health

"It's alarming that bacteria exposed to complex, unpredictable fluctuations can lead to resistance to antibiotics or heavy metals, and it could happen in about 30 days," says Dr. Karve.

"Climatology studies have shown that variability in the environment has drastically increased in many parts of the world, India included. As a result, there is a possibility that bacteria could show increased efflux activity and

greater resistance to antibiotics even when not exposed to them," says Prof. Dey.

The isolated Amazonian tribe that had no contact with civilisation till recently showed drug resistance can arise even when not exposed to antibiotics. The gut bacteria of this population showed resistance to latest antibiotics, including synthetic antibiotics, which are not found naturally in soil.

Another study (Journal of Evolutionary Biology) by the team found that unlike bacteria which had not evolved to handle stress in 30 days, the ability to cope with stress was significantly better when the exposure to complex, unpredictable environment continued for 100 days. "Besides better growth rate and greater ability to tolerate stresses, the bacteria showed no variation in their ability to handle different stresses compared with ancestors," she says.

In the latest study paper published a few days ago in the Journal of Evolutionary Biology, they investigated whether complexity or unpredictability that hinders adaptation over short term. And they found that bacteria could adapt to unpredictability when complexity was absent. They also found E. coli shows little adaptation to acidic pH as it is already very well adapted to it. In contrast, the bacteria show significant adaptation to salt, a stress for which it is poorly adapted to begin with.

University of Hyderabad increases bioavailability of harpin biopesticide

Researchers at the University of Hyderabad have found that harpin biopesticide brought about 80-90% reduction in severity of fungal infection in tomato plants when it is encapsulated in chitosan nanoparticles. The fungal infection was caused by Rhizoctonia solani. The reduction in disease severity is only about 50-55% when the biopesticide is used without loading it in nanoparticles. The results were published in the journal Carbohydrate Polymers.

Though harpin is used against several bacterial, fungal and viral infections, poor bioavailability is a major hurdle when harpin protein, taken from the bacteria Pseudomonas syringae pv. syringae, is just sprayed on the leaves like any other pesticide.

Chitosan to the rescue

To address the issue of poor bioavailability of harpin arising from the inability to permeate into plants, the researchers led by Prof. Appa Rao

Podile from the Department of Plant Sciences turned to nanotechnology. They used the biocompatible and biodegradable chitosan in nanoparticle size to encapsulate the biopesticide. Chitosan nanoparticles are capable of getting into the plant through the stomata (pores on the leaves through which gas exchange takes place) and then diffuse through the cell wall to enter the cells. The team found that chitosan nanoparticles containing harpin pass through the cell wall and end up in the chloroplast of tomato plants.

As a result, bioavailability of harpin inside tomato plants increases sharply when loaded in chitosan nanoparticles. Also, less amount of harpin will have to be sprayed on leaves when it is contained in nanoparticles.

Chitosan by itself has another advantage. “Chitosan’s antifungal property and its role in triggering plant defence responses are already well known. Its ability to biodegrade inside the plant without harming the plant cells is why we chose it for encapsulating harpin,” says Prof. Podile.

The disease severity in tomato reduced significantly and there was fivefold decrease in fungal biomass in the case of harpin encapsulated in nanoparticles compared with bulk harpin sprayed on leaves. While the fungus failed to colonise and infect tomato leaves upon extended incubation, it completely destroyed the leaves used as controls.

Laboratory studies found harpin was released from the nanoparticles in two phases. “The biopesticide adsorbed on the nanoparticles gets released in a burst in the first 48 hours followed by slow release up to 120 hours,” says Dr. Sandhya Rani Nadendla from the Department of Plant Sciences at UoH and first author of the paper.

Currently, the shelf-life of harpin nanoparticle is limited to 30 days as the encapsulation loses its efficiency. “The nanoparticles are currently stored in a liquid phase. We are trying to make some chemical changes at the time of preparation of chitosan nanoparticles to make it more stable. We are also trying to make it in a powder form by spray drying to further increase the shelf-life,” says Prof. Podile.

Tomato plants and R. solani fungal infection were only used as a model system to test the efficacy of chitosan nanoparticles containing harpin in controlling the disease. “The objective was not to develop an exclusive disease control method. We used this particular fungal infection as an index,” he says. “The plant defence activated by harpin is broad-spectrum so can control even bacteria.”

The team is planning to test harpin-containing chitosan nanoparticles on a large-scale on four different crops and at least two pathogens per crop. Two of the crops to be tested will be grown in fields and two others will be greenhouse crops.

Protein's novel role in embryo implantation studied

A large number of couples are infertile and in many cases IVF is not successful and there are repeated failures. In a latest development, Mumbai-based researchers have shown the molecular features of embryo–endometrium crosstalk that helps in embryo implantation.

The team led by Dr. Deepak Modi from ICMR's National Institute for Research in Reproductive Health (NIRRH) has discovered that the endometrium is not a passive tissue which readily promotes embryo implantation but undergoes extensive remodelling brought about by the embryo at the time of implantation.

They discovered that a protein OVGP1 is induced in the endometrium precisely at the time when the embryo has to implant. That the embryo can implant only during a narrow window is well known. Studies carried out in mouse models showed that OVGP1 protein is expressed for a brief period that coincides with the time of implantation. It is known that the pregnancy hormone — human chorionic gonadotropin (hCG) produced and released by embryos is crucial for the implantation process.

The role of hCG hormone in inducing the endometrium to produce the OVGP1 protein became clear when the researchers studied the role of different hormones on endometrial cell lines. The cell lines were exposed to progesterone, estrogen and human chorionic gonadotropin hormone. "We found the hCG hormone induced the expression of OVGP1 protein. Progesterone and estrogen, too, had a role, though minor, whereas hCG had a major role in the expression of OVGP1. This tells that embryos signal the endometrium to express OVGP1," says Dr. Modi, who is the corresponding author of a paper published in the Journal of Assisted Reproduction and Genetics.

To study how the protein helps in the implantation process, the researchers silenced the expression of the protein in the endometrium cell lines. They found that the expression levels of integrin proteins, which are essential for implantation, were significantly reduced in OVGP1 silenced cells. Similarly, homeobox protein HOXA10 levels too reduced significantly as did the cytokines, says Saniya Laheri from the Department of Biological Sciences, NMIMS, Mumbai and first author of the paper.

"We found the OVGP1 protein is required for balancing the expression of genes required for implantation," says Laheri. "We then wanted to test if the expression of the altered genes affects implantation."

For implantation to take place the trophoblast cells (the outermost layer of the embryo) have to adhere to the endometrial epithelial cells. When the OVGP1 protein was silenced in the endometrium the adhesion of the trophoblast gets reduced. "This led us to conclude that OVGP1 in the endometrial epithelial cells is required for embryo implantation," says Nancy Ashray from NIRRH, a co-author of the paper.

Women who had repeated IVF failure apparently had reduced levels of OVGP1 protein. "The levels of OVGP1 are reduced by 30% in women with repeated IVF failure," Laheri says.

"This is a very fundamental research and we are now beginning to understand how the embryo and endometrium have to crosstalk. This work in long term might have implications in management of infertility," says Dr. Modi.

IIT Bombay: Breakthrough in stem cell proliferation

A major obstacle in using human mesenchymal stem cells (hMSCs) to treat a variety of diseases has been successfully overcome by a team of researchers at the Indian Institute of Technology (IIT) Bombay. The team led by Dr. Abhijit Majumder from the institute's Department of Chemical Engineering found hydrogel plate made of polyacrylamide was a perfect replacement for conventionally used plastic culture plates. Unlike the plastic plates, the hydrogel ensured that stem cells multiplied and retained the stem cell-like nature (stemness) for up to 51 days (20 generations) and differentiated into bone, cartilage or fat cells. The pre-print findings are reported in bioRxiv.

When grown on plastic culture plates, the mesenchymal stem cells become large and flat, and also irregular in shape. The cells stop multiplying and growing (reach senescence) after a certain number of cell divisions. While only limited number of mesenchymal stem cells can be obtained from the body, a large number of cells is required for clinical applications. The only way to increase the number in the lab is to allow them to multiply. But multiplication to reach the desired numbers is currently not possible using plastic culture plates. And that is where the team's success with hydrogel substrate to grow the cells holds great promise.

"The problem becomes particularly acute in elderly patients as fewer numbers of mesenchymal stem cells can be recovered," he says.

Novel culture plates

"We did see senescence setting in at an early stage itself (day 5-6) and gradually increasing when plastic plates were used. But in the case of gel, there was an increase in senescence around day six but it remained constant after that," says Dr. Majumder. "Traction reduced, and the proliferative nature of stem cells got prolonged when we used the gel."

Mesenchymal stem cells adhere to the substrate and the cells tend to contract, causing traction force to set in. The traction force applied by cells increases with stiffness of the substrate on which it is grown.

Substrate stiffness, possibly via modulating cellular traction, determines how long the stem cells maintain their stem-like nature. Plastic plates have greater stiffness (in gigapascals), while gel used in the experiments have only 5 kPa.

"When we used gels that are too soft (1-2 kPa) stem cells failed to proliferate. Cells started dividing as we increased the stiffness of the gel. But beyond 5 kPa, the cell spread area [size] got affected and the ability to maintain proliferation was compromised," says Sanjay K. Kureel from IIT Bombay and first author of the paper.

When mesenchymal stem cells derived from umbilical cord were cultured on plastic plates and gel, the cells lost their morphology and entered senescence much earlier in the case of plastic plates. Similar results were seen in the case of mesenchymal stem cells derived from bone marrow.

"While the stem cells maintained their shape and proliferative potential for 33 days and beyond when cultured on gel, the proliferative potential started to reduce after day 15 when grown on plastic plates. That's why we got more cells at the end of the experiment when we used gel," says Pankaj Mogha from IIT Bombay and the other first author of the paper. "The doubling time [time taken for cells to double in number] also increased when plastic was used."

Thus by 50 days, a huge difference in the doubling time was seen — 512 times more stem cells were obtained when they were cultured on gel than on plastic plates. Put simply, one cell multiplied to become 4 million cells after 50 days when cultured on plastic plates, while one cell cultured on gel gave rise to 2,000 million (2 billion) cells.

"We could show that physical microenvironment is associated with senescence. And the use of gel reduces the time taken to attain a large number of cells that can differentiate into specialised cells. This becomes

particularly important when we seek to treat patients who are more vulnerable to infection or need immediate therapy," Dr. Majumder says.

Silk-based bioactive wound dressing and skin graft

Researchers at the Indian Institute of Technology (IIT) Guwahati have developed bioactive wound dressings and bio-artificial skin by using silkworm silk fibroin as matrix and coating it with recombinant spider silk proteins. If animal trials are also successful, the wound dressing might help in treating chronic and severe wounds such as diabetic foot ulcers, while skin graft might come handy for burn patients.

Wound dressings

While wound dressings reduced bacterial population by nearly fourfold and showed good anti-biofilm properties, the silk scaffolds seeded with human dermal and epidermal cells led to the development of bio-artificial skin. The team led by Prof. Biman Mandal from the Department of Biosciences and Bioengineering also vascularised (develop blood vessels) the bio-artificial skin by using human dermal microvascular endothelial cells. The results of the study were published in the journal ACS Applied Materials & Interfaces.

Nanofibrous silk mat for wound dressing was prepared using silkworm fibroins as the matrix and was coated with 0.1 mg/ml of recombinant spider silk proteins containing antimicrobial peptides, cell binding protein and growth factor peptide. Whereas the growth factor stimulates cell proliferation and recruits cells to the site of wound, the cell binding protein also helps in recruiting cells to the wound site and in the cell migration process.

"The spider silk has high affinity towards silkworm silk and so readily self-assembles as a thin coating on top of the matrix without the use of any chemicals. Since the interaction between spider and silkworm silk is strong the coating remains stable," says Dimple Chouhan from IIT Guwahati and first author of the paper. Both mulberry and non-mulberry silk varieties were suitable for producing the matrix, with the non-mulberry silk showing quicker and stronger self-assembly with spider silk.

If silkworm silk matrix is directly functionalised then more volume of the active compounds will be required and tunable delivery of the compounds will also be difficult.

The functionalised spider silk used in the study was developed by Dr. My Hedhammar from KTH Royal Institute of Technology, Stockholm, Sweden, and coauthor of the paper.

The two cationic peptides — Magainin I and Lactoferricin — contained in the spider silk-coated silk mats showed good antibacterial activity against two of the most common bacteria found in wounds — Pseudomonas aeruginosa and Staphylococcus epidermidis. "The cationic peptides are non-specific and so can target most bacteria present in the wound. We tested the peptides against both Gram-positive and Gram-negative bacteria and the peptides reduced the population of both and stopped bacterial growth," says Prof. Mandal. The peptides did not allow biofilm formation till the end of 24 hours of study.

Since chronic wounds lack cell binding proteins and growth factor to recruit skin cells to the site, the healing gets delayed or obstructed. But the presence of these proteins and antimicrobials in the coated silk mat helped the team achieve "functionally active mats" for wound dressing.

Skin grafts

To develop bio-artificial skin grafts, a soft, porous scaffold made of silkworm silk protein was coated with recombinant spider silk protein containing RGD proteins that promote cell binding and proliferation. Under in vitro conditions, the scaffold was cultured with human dermal (fibroblasts) and epidermal (keratinocytes) skin cells. While the dermal and epidermal skin cells led to the development of a bilayer skin graft, blood vessels were formed in the skin graft by culturing the scaffold with human dermal microvascular endothelial cells.

"We maintained the scaffold co-cultured with two skin cells types and blood vessel-forming cells for 21 days and developed skin grafts," says Chouhan. "We could mimic both the epidermal and dermal layer of the skin and thus come up with a facile, efficient and affordable way to develop functionalised constructs for tissue engineering and possible drug screening applications."

"We are currently performing follow up studies using various animal models to examine the efficacy of bioactive constructs, to understand the healing properties and study cell-material interactions," Prof. Mandal says.

IISER Pune uses Nano vesicles to improve cancer drug delivery

By encapsulating the poorly water-soluble anticancer drug Alisertib in polysaccharide nano-sized balls or vesicles, researchers at the Indian Institute of Science Education and Research (IISER) Pune have been able to increase its uptake by breast cancer cells and achieve greater ability to restrict cancer cell growth. Better uptake of the drug when encapsulated

meant lower concentration of the drug was sufficient to restrict cancer growth significantly better than the free drug.

The study, which was started about six years ago, gains importance as the drug by targeting AU`RKA now selectively inhibits RalA protein thereby disrupting cancer cells' ability to grow without anchorage (anchorage independent growth). Anchorage independence in tumors is what allows cells to spread and grow at new sites in the body — metastasis.

Target protein

Since producing inhibitors against RalA protein is challenging and the existing inhibitor is not specific (targets both RalA and RalB), the researchers chose to target Aurora Kinase A (AURKA) instead. Aberrant AURKA activity has been implicated in cancer formation, and its inhibition could potentiate the effect of chemotherapies. When AURKA is silenced, RalA protein, which is present downstream, gets automatically (and selectively) inhibited.

The researchers embedded breast cancer cells in 3D gels (collagen or agarose) and incubated them with nanovesicles containing the drug and a florescent dye. In 15 days the breast cancer cells grew into a colony in the 3D gel. About 75% of the encapsulated drug was retained in the nanovesicle and carried into cancer cells during the 15-day period.

"While the free drug did not inhibit the colony forming ability of cancer cells, the number of colonies was significantly reduced in the presence of nanovesicles loaded with the drug," says Prof. Nagaraj Balasubramanian from the Department of Biology who led the team along with Prof. Manickam Jayakannan from the Department of Chemistry, IISER Pune.

The encapsulated drug produced 94% inhibition of the target AURKA leading to 25% inhibition of RalA; the drug did not affect RalB. As a result, there was 38% inhibition of anchorage independent growth of cancer cells.

In comparison, at 50%, the Ral inhibitor achieved greater inhibition of RalA than the encapsulated drug but the inhibition was not specific — RalB was inhibited by 64%. The inhibition of anchorage independent growth was only 33%.

"What was interesting is that besides being specific to RalA, the encapsulated drug achieved greater inhibition of anchorage independent growth than the Ral inhibitor. This despite the Ral inhibitor achieving double the inhibition of RalA than the encapsulated drug," says Prof. Balasubramanian. The results were published in the journal Molecular Pharmaceutics.

For this study, the nanovesicles were encapsulated with only one drug (Alisertib) in the hydrophobic envelop while a fluroscent dye was loaded in the hydrophilic core. But the 2014 study (published in the journal Nanoscale) by the team showed that loading the nanovesicles with two drugs enhances the therapeutic efficacies against cancer cells.

Hydrophobic and hydrophilic anticancer drugs loaded in the envelop and core of the nanovesicle respectively performed better than free drugs and synergistically killed breast and colon cancer cells. The proof-of-concept study was published in 2012 in Biomacromolecules.

"We are aiming to start animal studies in mice to study how well the drug contained in nanovesicles is able to inhibit breast cancer tumours. We are also using this drug loaded in nanovesicle to inhibit and study the role of AURKA and RalA in normal and cancer cells. So it also becomes a tool to understand the role of these proteins in cells," he says.

Fabricating nanovesicles

"To make the nanovesicles self-assemble, we undertook some modifications to the dextran polysaccharide using a molecule from cashew nut shell extract," says Prof. Jayakannan. "Since both are from bio-based nanosystems, the nanovesicles are not toxic to cells, and possibly human, and are biodegradable."

"The nanovesicle is bilayered and is held together to form a stable vesicle through hydrophilic-hydrophobic interactions," Prof. Jayakannan says. Since the nanovesicles are about 120 nanometre in size, they are easily taken up by cancer tissue but not normal tissue.

Also, nanovesicles with the drugs loaded become water dispersible thus increasing the uptake by cancer cells. "We are working to make the nanovesicles even more specific to cancer cells," Prof. Jayakannan says. The drug-loaded nanovesicles are cleaved by esterase enzyme once inside the cell.

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Mouse brain allows neuronal patchwork to succeed

Brain tissue can incur damage due to degeneration or injury, and one way to repair this is to transplant neurons which will merge with the surrounding tissue and connect with the other neurons in the neighbourhood to make up for the damage. A study carried out by an international collaboration determines the conditions under which neurons implanted in the brain of mice can successfully integrate with the surrounding tissue.

The researchers implanted newly born neurons, taken from the cerebral cortex of mouse embryos into brains of other newborn mice. The cerebral cortex is the region responsible for higher-level functions such as voluntary control of movement and cognition. These embryonic neurons are normally capable of maturing into adult neurons that form long distance connections between parts of the brain. "We optimized the method of transplantation and limited the number of cells that we injected into a recipient brain so that we can analyze these cells individually at a later stage," Thomas Wuttke, first author of the paper published in Nature Neuroscience says in an email.

The transplanted neurons were labelled with a fluorescent protein (eGFP) which is derived from a species of jellyfish. "Due to labeling, we were able to visualize the transplanted neurons within the brains of the recipient pups and distinguish them from nearby recipient-derived neurons," says Dr Wuttke.

Experiments showed that the transplanted neurons could form appropriate connections within the brains of the recipient mouse pups when analysed at the level of single cells. "This suggests that by transplanting appropriate types of immature neurons we can potentially reconstruct a neuronal circuitry, at least in the context of a newborn animal," he adds.

Earlier, pioneering work had shown that neurons implanted in the brain could take root there and also send out long axons (wire-like extensions that help transmit signals) and connect to nearby neurons. However, those experiments were done with bulk transplantation of large numbers of neurons. "Bulk cell experiments are not appropriate for looking at transplanted neurons on a cell-by-cell basis to determine if they mature as required and form correct connections," says Hari Padmanabhan, co-author of the paper, who is with the Department of Stem Cell and Regenerative Biology, Harvard University.

"This has important implications when we consider transplanting new neurons for correcting diseases caused by neuronal loss that happens either through degeneration or via injury," he explains.

"We reported, for the first time, that transplanted immature but developmentally 'primed' neurons of specific and distinct projection neuron subtypes can integrate cellularly and positionally into postnatal cortex; maintain remarkable fidelity of differentiation and maturation, establish subtype-specific and appropriate long-distance connectivity; and bi-directionally integrate electrophysiologically into local and long-distance circuitry," says Jeffrey Macklis of harvard University who led the study.

Novel method developed to measure protein digestion

By labelling spirulina and two legumes (chick pea and mung bean pea) with stable, nonradioactive isotopes of carbon (13C) and hydrogen (2H) respectively, researchers at St. John's Research Institute have found a new way to accurately measure the digestibility of dietary proteins.

In the six adults who consumed the labelled proteins, 85% of the spirulina protein was absorbed while only about 57% was absorbed in the case of both chickpea and mung beans. The results were published in the American Journal of Clinical Nutrition.

The research team led by Anura V Kurpad from the Institute's Department of Physiology found that removing the hull or skin of mung bean before ingestion increases the average digestibility of essential amino acids by 10%. There are two ways by which the hull reduces digestibility. While anti-proteases present in the hull block the action of intestinal digestive enzymes, the polyphenols in it reduce the activity of the digestive enzyme.

"We knew the hull has anti-nutrition factors that hinder digestion and that dehulling will increase amino acid digestibility. But the 10% increase in digestibility when dehulled was not expected," says Sarita Devi at the Institute's Division of Nutrition and first author of the paper.

"The hull has less effect in the case of chick pea whereas it is a substantial problem in mung bean," says Prof. Kurpad.

In another study, which will soon be published in the American Journal of Clinical Nutrition, the team used stable isotopes to label and measure protein digestion in meat (chicken) and egg. At 92%, the essential amino acid digestion was highest in cooked chicken, followed by whole boiled egg at 89% and egg white protein at 86%.

"The amount of essential amino acid digested and absorbed is far higher in animal-source protein than plant-based protein," says Prof. Kurpad. "In contrast, one has to consume about 40% more dal to get the same amino acid into the body as animal source protein. On the other hand, legumes are good for the environment and land and offer many other beneficial nutrients and so a balance has to be reached when deciding on the source of high quality protein foods in the diet."

Of the 20 amino acids that we need, the body cannot synthesise nine; dietary protein is the only source of these essential amino acids. But till now there was no way to know how well the protein consumed is digested and absorbed by the body.

The crude method adopted so far was to feed protein-rich food and measure the nitrogen content in the faeces. "But protein is only digested and

absorbed in the small intestine. In the large intestine the microbiome takes away or adds nitrogen. So measuring nitrogen in the faeces as an index of what has been digested and absorbed can be misleading," says Prof. Kurpad. "If you have wrong information about digestion, we will end up with wrong recommendation for the quantity of specific food-based protein to be consumed."

The team has been working for over 15 years on a stable carbon isotope (13C) method that they developed to measure the true amino acid requirement in humans.

"Since even digestion measurement was not correct, owing to difficulties in accessing small intestinal events, we devised the dual-isotope method to measure digestion in the small intestine," he says. These results, while setting up a new method, will inform policies on feeding populations and individuals the appropriate amounts and types of food.

Novel biomarkers for gastric cancer progression

With stomach cancer figuring as the third leading cause of cancer deaths worldwide, researchers from University of Delhi and National Institute of Cancer Prevention and Research, Noida have identified two proteins—survivin and STAT3—that can be potential markers of the disease. According to them, these proteins could also be suitable therapeutic targets in preventing gastric cancer progression.

From 2007-2012, in all 156 gastric samples were collected from a hospital in Allahabad and studied. Of these, 30 were precancerous tissues, 65 were in the advanced stage of stomach cancer (adenocarcinomas) and the rest were normal healthy tissues. Protein expression studies revealed that survivin and STAT3 were produced in abundance (overexpressed) during gastric tumour progression.

"Survivin plays a dual role. Normally, it is in the nucleus and is associated with cell proliferation, whereas in advanced tumours it has been observed in cytoplasm and mitochondria, which is linked to chemoresistance. This means that in patients, when it is overexpressed in cytoplasm, it can inhibit cell death," explains Prof. Alok C. Bharti from the Molecular Oncology Laboratory at the University of Delhi and corresponding author of the work published in Cancer Reports. "Therefore, the protein can help cancer cells to survive in harsh toxic conditions and to withstand chemoradiation, causing the patient to not respond or poorly respond to chemotherapy."

Genetic analysis

The researchers also looked at the presence of key pathogenicity inducing gene cagA of Helicobacter pylori and identified strong correlation between presence of the gene and increased expression of survivin and STAT3.

Lifestyle habits like smoking and alcohol consumption were also found to be the causes for increase in the expression of these proteins. But when these habits came together along with H. pylori infection, the expression of survivin was characteristically very high. These molecular markers can be present even when the lesion is small and have larger implications as they point to future progress of the disease.

"It is a very simple, easy test to detect the level of these molecular markers. Detection of cagA gene is done by standard PCR and the immunohistological analysis for the proteins could be performed in a lab and does not require sophisticated infrastructure. The reagents required are also generic and not expensive, and the analysis can be done by any expert pathologist," says Dr. Arvind Pandey, first author of the study who did his PhD at the institute.

Currently there is no specific clinically-available method to study gastric cancer progression. Further standardisation is needed to translate it into clinical reality.

IISER Bhopal strike at the root of head and neck cancer growth

Researchers at the Indian Institute of Science Education and Research (IISER) Bhopal have found that depleting the production of a specific protein kinase (p21-activated kinase 2 or PAK2), which is normally produced in excess in head and neck cancer, affects a chain of events that finally reduces the growth of head and neck cancer.

In cancer cells, the PAK2 protein is responsible for increased cell proliferation, cell migration, invasion into the extracellular matrix, colony formation and even resistance to certain cancer drugs. The team led by Prof. Sanjeev Shukla from the Institute's Department of Biological Sciences found the PAK2 protein was produced in excess (overexpressed) in 24 of 26 human cancer samples.

Interfering with PAK2

When the production of this protein was reduced in three head and neck cancer cell lines, the cancer cells became less viable and had reduced ability to proliferate, migrate, form colony and even resist cancer drugs. These studies showed the importance of interfering with PAK2 protein levels to

control head and neck cancer. So the researchers set to find the molecular mechanism behind the role of PAK2 protein in cancer growth.

"What we found was when the PAK2 protein level was reduced, the activation of a certain (beta-catenin) signalling pathway was inhibited," says Prof. Shukla. This pathway is important as its activation is associated with downstream target genes that play an important role in cancer growth. "So we hypothesised that the beta-catenin signalling might be dependent on PAK2 protein level and inhibiting the pathway will affect the expression of a well-known cancer gene c-Myc," he says. The c-Myc gene is produced in excess in head and neck cancer and is responsible for cancer cell growth.

"When we depleted the amount of PAK2 protein in cancer cells we found the activity of the signalling pathway getting affected, which then led to reduced expression of the cancer gene," says Amit Gupta from the Institute's Department of Biological Sciences and first author of a paper in the journal Cell Death & Disease.

Cascade of events

In a cascade of events, the reduced expression of the cancer gene causes a reduction in the amount of cancer-specific metabolic enzyme PKM2 produced. The PKM2 enzyme plays an important role in increasing the rate at which the glucose gets converted into lactate in cancer cells, which provides energy and also supports rapid cell division by providing the building blocks for forming new cells. So any reduction in the PKM2 level severely compromises cancer cells' ability to proliferate and migrate.

Unlike in normal cells, the glucose metabolism is not complete in cancer cells. So the glucose gets converted into lactate leading to less energy availability in cancer cells. Cancer cells tend to compensate for this by increasing the rate of glucose to lactate conversion and also by taking up more glucose from the surrounding environment.

"The involvement of PAK2 protein in other cancers is already known. But the cascading effect of PAK2 depletion in compromising the expression of the cancer gene (c-Myc) and cancer-specific metabolic enzyme (PKM2) was not known," says Prof. Shukla. "This is the first study to report this and its role in head and neck cancer progression."

"It might be possible to develop inhibitors to target the PAK2 kinase to help treat head and neck cancer. More studies are needed before inhibitors are used but there is a potential," says Prof. Shukla.

"The PAK2 protein is also responsible for chemotherapeutic resistance. So it might be possible to enhance the efficacy of currently available cancer drugs by combining them with PAK2 inhibitors," says Gupta.

Mcr-1 gene seen in K. pneumoniae bacteria

Increased prevalence of mcr-1 gene that confers multidrug-resistance has now been reported in Klebsiella pneumoniae bacteria, increasing the fear of infection by pan drug-resistant bugs. This gene endows resistance against last hope antibiotic — colistin. A study published in Antimicrobial Agents and Chemotherapy found that about 10% of the K. pneumoniae bacteria studied were resistant to colistin.

During January–February 2016, a total of 200 K. pneumoniae isolates from pus, blood, sputum, and urine were studied. Of this, 21 were resistant to colistin, and further screening revealed that four harboured mcr-1 gene.

"This gene was first reported in December 2015 in E. coli isolated from chicken in China, and by 2017 it had spread to all continents and [is] seen in bacteria isolated from humans, chicken and environment," says Prof. Kashi Nath Prasad from the Department of Microbiology at Sanjay Gandhi Postgraduate Institute of Medical Sciences, Lucknow, and the corresponding author of the work. "Evidence suggests that the overuse of colistin in farm animals has given rise to the emergence of mcr-1 gene. Since this gene is present on a mobile genetic element (plasmid) of bacteria such as E. coli and K. pneumoniae, the frequency of transmission to other bacteria is likely to be very high."

Molecular studies revealed that one particular isolate carried mcr-1 gene and blaNDM-1 gene. "The blaNDM-1 encodes for a protein that gives resistance to all beta-lactam antibiotics. This shows that the particular isolate was resistant to carbapenems, third-generation cephalosporins, aminoglycosides and fluoroquinolones (ciprofloxacin, levofloxacin) making the treatment very difficult," says Sanjay Singh, research scholar at the institute and first author of the work.

Evolved gene

Interestingly, mcr-1 gene was seen in the chromosomal DNA of the bacteria. "The mcr-1 gene is usually found in the plasmid (small DNA in the cytoplasm) and the resistance gene is transmitted among different species. But now we have found this gene in the chromosome showing that it has evolved and stabilised. Whole genome sequence studies are needed to understand the exact location of this gene to decode how they are transmitted from one bacterial species to another," adds Mr Singh. "The

presence of the gene in the chromosome also means that Indian population may be harbouring mcr-1 gene for a longer period of time and it remained undetected."

Further studies by the group also found that mcr-1 gene was more prevalent inK. pneumoniae than E. coli, which is in stark contrast to findings from other countries. While less than 1% of the E. coli studied was resistant to colistin, it was about 10% in the case of K. pneumoniae. More studies are needed to understand this contrasting behaviour. The team is also looking for this gene in other bacteria causing human infection and its mode of dissemination.

IGIB team finds a new target to reverse iron overload disease

Using zebrafish, researchers at the Institute of Genomics and Integrative Biology (CSIR-IGIB) have successfully discovered a pathway that regulates hepcidin hormone production. The hepcidin hormone, released by the liver, is a central regulator of iron in the body. Dysregulation of the hormone leads to anaemia on one hand and excess iron accumulation in organs such as liver and heart leading to multi-organ failure.

Hemochromatosis is a rare hereditary disease that is characterised by iron accumulation or overload in various tissues. The symptoms are non-specific and hence difficult to diagnose. Current options only manage the disease by removing excess iron. "One method is to bleed the patients and the other is to absorb iron using iron chelation, which is toxic to liver and kidney and may also cause hearing problems. There is no therapy currently available," says Sandeep Basu from CSIR-IGIB and first author of a paper published in ACS Chemical Biology.

Gene mutations

Mutations in about six genes are known to cause reduction in hepcidin hormone production thereby causing excess iron accumulation. But for the study, the research team led by Chetana Sachidanandan created a disease model in zebrafish by mutating one of these genes (TFR2). Mutations in the TFR2 gene cause a severe form of the disease.

The zebrafish with the mutant gene showed excess iron accumulation in organs, quite similar to what is seen in humans.

In the conventional drug discovery approach, the target protein and even the pathway are already known and molecules that would either inhibit or overproduce the target protein are screened for. But the researchers adopted a different approach for this study.

"Hepcidin gene is controlled by many factors, many of them not well understood. So, instead of picking one target for our drug screen, we focused on the symptoms of the disease — excess accumulation of iron," says Dr. Sachidanandan. "We knew that hepcidin hormone is low in the hemochromatosis patients, and that this causes iron overload."

Since the researchers knew hepcidin production is regulated by many signalling pathways, they selected 80 compounds that specifically target signalling pathways in zebrafish. Of the 80 compounds tested, eight were found to induce the production of hepcidin hormone in the fish. "One of these compounds is a blocker of NFkB signalling pathway. This pathway was not known to be important in hepicidin regulation in the liver." This is the first time that researchers have been able to identify and tell that the NFkB pathway regulates liver hepcidin production.

Unbiased strategy

"It was not a blind screening, but rather we used our existing knowledge about hepcidin regulation. When we don't have a deep understanding of a disease, but need to discover drug candidates, this kind of unbiased strategy is more efficient," she says.

The researchers tested the ability of this compound to regulate hepcidin production. "The small molecule targets and inhibits the NFkB pathway signaling thus increasing hepcidin production and reducing iron overload," says Basu. They tested three more compounds that target the same pathway to confirm that the NFkB pathway is indeed a key to regulating hepcidin production. "There are other signalling pathways that regulate hepcidin production but our discovery places NFkB pathway as an important negative hepcidin hormone production," Basu says.

When the pathway in the zebrafish model of Hemochromatosis was inhibited using the four compounds, the hepcidin production was restored and iron overload was reduced, thus reducing the severity of the disease.

To further reconfirm the role of the NFkB pathway, the researchers removed it in zebrafish. This led to overproduction of hepcidin hormone in the fish, confirming that the pathway negatively regulates the production of the hormone.

None of the four compounds tested in zebrafish is approved for use in humans; one compound tested is approved for use in poultry. "The target pathway has been identified even though the tested compounds cannot be used as drugs. What is important is that we have found a strategy for

therapy," says Dr. Sachidanandan. "Now that we know the pathway to be targeted, it's easier to discover drug molecules."

"We are now working to see if we can apply this therapeutic strategy for Thalassemia patients," Basu says.

Bed net to prevent malaria

Researchers have developed a new type of bed net with a specific combination of an insecticide and insect growth regulator that could prevent millions of cases of malaria.

The novel net, detailed in the journal The Lancet, contains a pyrethroid insecticide, which repels and kills the mosquitoes, and an insect growth regulator, pyriproxyfen, which shortens the lives of mosquitoes and reduces their ability to reproduce.

This new type of mosquito net reduced the number of cases of clinical malaria by 12%compared with conventional nets. There was also a 51% reduction in risk of malaria infective mosquito bite.

Children using the new bed nets were 52% less likely to be moderately anaemic, which is a major cause of mortality in children under two years, the research showed.

"This new invaluable tool would enable us to tackle more efficiently this terrible and deadly disease that affects many children," said principal investigator Alfred B. Tiono, from the CNRFP in Africa. The team conducted a two-year clinical trial in Burkina Faso, West Africa, involving 2,000 children, aged between six months and five years.

The latest figures from the World Health Organisation shows that in 2016 malaria infected about 216 million people across 91 countries, up from five million in 2015.

IIT Roorkee finds new drug target for antibiotic resistant bacteria

Researchers at IIT Roorkee have identified a protein (Hfq) in Acinetobacter baumannii bacteria that can be a potential drug target. The Hfq protein plays an important role in metabolism, drug resistance, stress tolerance and virulence. The protein stabilises the interaction of small RNA with its target mRNA molecules.

A. baumannii bacteria are resistant to several antibiotics. They also survive in dry, desiccated conditions for extended periods.

While most Gram-negative bacteria have Hfq protein, the protein is particularly long in the case of A. baumannii. In E. coli, the length of the Hfq protein is only about 100 amino acids while there are 168 amino acids in the case of A. baumannii. The end of the Hfq protein, called the C-terminus is what is particularly long in A. baumannii. While another study had reported that the extra length of the C-terminus may not be significant in another bacteria belonging to the same family as A. baumannii, the team found evidence to the contrary.

The team led by Ranjana Pathania from the Institute's Department of Biotechnology found that when the Hfq gene was removed (knocked out), the bacteria became susceptible to environmental stress, showed stunted growth, survival under desiccation was compromised, and the ability to form biofilm was reduced. "But most importantly, the virulence of the bacteria was significantly reduced in mice model infected with the mutant bacteria," says Prof. Pathania. The results of the study were published in The Journal of Biological Chemistry.

To reconfirm the role of the extra length of Hfq protein, the researchers complemented or added the full length of the protein and also Hfq protein of different lengths (66, 72 and 92 amino acids). "While the full length of the complemented protein could restore all the functions and processes, including virulence, the Hfq protein lacking the C-terminus tail could not restore the functions of the protein. So it became apparent that the C-terminus tail is important," she says.

The resistance to two commonly used antibiotics reduced twofold when the bacteria lacked the Hfq gene, but the resistance increased nearly fourfold in the case of another antibiotic. "We are currently studying the mechanism by which the resistance increases in the case of the other drug (Meropenem)," she says.

More than the gene's role in altering drug resistance, the researchers are thrilled at how removing the Hfq gene causes the bacteria to lose its ability to cause disease and the growth getting compromised. "Targeting the virulence of the bacteria is a rather new concept which promises drugs that don't lead to rapid generation of resistance. Identification of Hfq as a virulence factor in the bacteria opens up a new opportunity to develop more effective drugs," says Prof. Pathania.

"Since the Hfq gene controls multiple pathways in the bacteria, it will be difficult for the bacteria to develop resistance against any drug that targets this gene," says Prof. Pathania.

New compound to strike H. pylori

With the World health Organisation listing H. pylori among the 16 antibiotic-resistant bacteria that pose the greatest menace to human health, there has been a growing concern about the bacteria and finding new treatments for the infection.

Now, researchers from National Institute of Cholera and Enteric Diseases (ICMR-NICED), West Bengal have assessed a compound (ellagic acid) against H. pylori and found that it can kill almost all clinical strains of this bacterium. Ellagic acid was also found to aid in the healing of the damaged gastric tissue in mice model.

"Treatment for H. pylori infection has not significantly changed over the last decade. The efficacy of the conventional antibiotic therapy is not always satisfactory and now H. pylori isolates have gained high-level resistance to antibiotics, including metronidazole, clarithromycin, and tetracycline signifying a serious dilemma," says Dr. Asish K. Mukhopadhyay from NICED and corresponding author of the paper published in Journal of Antimicrobial Chemotherapy. "There is a strong need to explore new non-antimicrobial agents that are cost-effective, safe and applicable to all H. pylori infection."

Plant-derived

The researchers examined ellagic acid, a major polyphenolic component of fruits, vegetables and nuts which has been previously reported to have antibacterial properties. The antimicrobial property was tested against 55 different H. pylori isolates collected from gastric biopsies of patients. Most of the strains were resistant to clarithromycin, metronidazole or amoxicillin. About 5-30 mg/L of ellagic acid was tested on these drug-resistant strains and about 74% of the bacteria were killed at 15 mg/L. The morphology of the bacteria changed when treated with ellagic acid.

"The H.pylori bacteria are normally motile and spiral in shape but after treatment the bacteria shifted to non-motile spherical or coccoid form. We think that ellagic acid is possibly killing the bacteria by apoptosis. More studies are needed to fully understand the pathways of the compound," says Ronita De, the first author of the paper.

M ice model studies also showed that ellagic acid given for seven days not only killed the bacteria but also almost completely restored the gastric epithelial damage induced by the organism.

"Ellagic acid is a good antioxidant and can boost immunity of the body. Also H. pylori induced oxidative stress is neutralised. It can prove to be an

inexpensive, diet-based treatment supplement," adds Avijit Sarkar, Post-Doctoral Fellow and one of the authors of the work.

Aptamer inhibits TB bacteria entry into cells

By using a small single-stranded DNA molecule (DNA aptamer) that specifically binds to a single protein (HupB) present in TB bacteria, researchers have been able to achieve 40–55% reduction in the bacteria's ability to enter into human cells and infect them. Besides facilitating entry into host cells, HupB also helps the TB bacteria survive various stresses encountered inside host cells.

The HupB protein was discovered in late 1990s by Prof. H. Krishna Prasad, formerly with AIIMS, while looking at specific TB bacterial antigens that induced immune response in humans. He found the protein was associated with the DNA of the bacteria (Tubercle and Lung Disease journal).

"Since it is associated with the DNA, we didn't expect it to be found on the surface of the bacteria. But to our surprise, it was seen on the surface of the TB bacteria too," recalls Prof. Prasad. Further studies showed that the HupB protein was able to interact and bind to proteins found on the surface of host cells, which will facilitate the entry into host cells.

"HupB is an essential protein of TB bacteria and so an attractive drug target," says Prof. Jaya Sivaswami Tyagi from the Department of Biotechnology at AIIMS and one of the corresponding authors of a paper published a few days ago in the journal Molecular Therapy - Nucleic Acid.

Despite being an attractive drug target, designing inhibitors against HupB has been largely unsuccessful as the full length crystal structure of the protein is not known due to the disordered nature of the end portion of the protein (C-terminal). As a result, the classical drug discovery route, which relies on the structure, cannot be used for designing inhibitors against HupB protein.

And this is where aptamers come in handy; there is no need to know the structure of the protein when aptamers are used. "Since aptamers are selected based on their affinity to bind to the molecule being targeted, we turned our attention to search for aptamer-based inhibitors," says Prof. Tyagi.

From a collection of two types of DNA libraries, the researchers selected 23 aptamers. Of the 23, only two aptamers (4T and 13T) were chosen based on high binding affinity and specificity to the HupB protein. Both the aptamers remained stable when exposed to serum, an essential requirement for an inhibitor. The aptamers were found to bind at different positions of the

protein. Also, the binding was four-fold higher when the aptamers bound to the full-length protein than when bound to only the N-terminal portion of the truncated protein, suggesting the importance of C-terminal for efficient binding.

While the cell-surface associated HupB protein facilitates the entry into host cells, the protein that binds to the TB bacteria's DNA protects the bacteria from multiple stresses inside the host cell.

The binding of the aptamers to the cell-surface associated HupB protein was first confirmed using live, disease-causing TB bacteria. The researchers then treated the disease-causing TB bacteria with the aptamers to test the ability of the bacteria to enter human cells.

"Compared with controls, the aptamer-treated bacteria showed reduced ability to enter the host cells. At 55%, the HupB-13T aptamer had greater ability to inhibit TB bacteria entry than the HupB-4T (42%) aptamer," says Dr. Tarun Kumar Sharma from Centre for Biodesign and Diagnostics, Translational Health Science and Technology Institute (THSTI), Faridabad and another corresponding author of the paper.

A vital protein

"The TB bacteria use a number of proteins to enter host cells. But their entry into host cells is inhibited 40-55% when the HupB protein alone is inhibited. This shows how vital the HupB protein is in modulating the bacterial entry into host cells," says Priya Kalra from the Department of Biotechnology at AIIMS and first author of the paper. But will the inhibition to enter host cells be greater if both the aptamers are used simultaneously? "Ideally, both the aptamers can be used. But no study was done to determine this. We speculate that the cocktail will have a complementary effect. But it is hard to say by how much the invasiveness will be reduced when the aptamers are used together," says Kalra.

Using the HupB protein alone, the researchers tested the ability of the aptamers to inhibit DNA binding. At 75%, the HupB-4T aptamer showed greater DNA binding inhibition than the HupB-13T aptamer (25%). Inhibition of DNA binding will make the bacteria vulnerable to stress inside the host cells, leading to death.

Killing TB bacteria

"We are now trying to deliver the aptamer into the TB bacterial cell to inhibit the DNA-binding function of HupB. But it is a huge challenge as there are three barriers to cross before getting inside the bacteria membrane. The infective TB bacteria present inside a human cell are enclosed by a

phagosome vesicle. So the aptamer has to first cross the human cell wall, then the vesicle and finally the TB bacteria cell membrane, which is particularly thick," says Prof. Tyagi.

"With increasing drug resistance and the difficulty to come up with safe and efficacious drugs, the aptamer-based approach is ideal as HupB protein is vital for survival of the bacteria," says Dr. Sharma. "So by targeting the HupB protein using aptamer-based inhibitors can effectively block TB infection and will be effective in both drug-sensitive and drug-resistant TB patients."

JNCASR: Electrochemical sensor detects dopamine, paracetamol

Developing electrochemical sensors to detect dopamine and paracetamol in the body is an active field of research. A team from Jawaharlal Nehru Centre for Advanced Scientific Research, Bengaluru, has come up with a nanocomposite material made of platinum-doped cerium oxide and cuprous oxide that works efficientlyin electrochemical cells to detect their levels, in combination, in spiked human urine and serum samples.

Neurotransmitters transmit signals from one neuron to another; dopamine is one such which is responsible for reward-motivational behaviour, among other things. When not present in the right amount, it can lead to, for example, Parkinson's disease. Paracetamol is a drug commonly used to treat pain and fevers; however, if present above a critical concentration, this can affect the sympathetic nervous system. Dopamine levels have been known to be affected by long-term use of paracetamol. Thus, it is useful to know the levels of these two chemicals in the body simultaneously.

To detect the concentration of an analyte, electrochemical methods measure the potential and current in an electrochemical cell containing the analyte. In this case, the analytes to be detected are dopamine and paracetamol. The electrochemical cell used by the researchers had three electrodes: the working electrode consisting of the nanocomposite material (platinum doped cerium oxide and cuprous oxide); the counter electrode (platinum wire) and reference electrode (silver-silver chloride) explains Sebastian C Peter, of JNCASR, in whose lab the experiments were done.

The need for the electrodes made of nanocomposite arises because, if instead, a bare electrode were used, several problems could arise, such as a low potential gap between analytes and interference with other biomolecules, to mention just two. Therefore, the researchers modified the surface of the electrode with the given nanocomposite material. "Chemically modified electrodes are highly preferred due to their large surface area,

reversible redox activity, high surface oxygen mobility, chemical inertness, bio-compatibility, non-toxicity and applicability over a wide range of areas," says Dr Peter. The work is to be published in ACS Applied Nano Materials.

In recent times, the use of cerium oxide–doped graphene nanocomposites has been in vogue. This is mainly due to the electrochemical properties of cerium oxide. The cerium oxide nanoparticles have dual oxidation states of cerium and this delivers catalytic properties, leading to their action as a radical scavenger on the surface. This facilitates oxidation of dopamine and paracetamol. In this, the researchers innovated by adding platinum to the nanocomposite. "Introducing platinum has great significance due to the high electrocatalytic activity, outstanding conductivity, adsorption capabilities and biocompatibility in electrochemical sensors," Dr Peter adds.

While in its bare form, cuprous oxide, too, has good electrocatalytic activity towards oxidation of biomolecules, its use is limited by its dispersion on the unmodified electrodes.

"The peak potential of dopamine and paracetamol is fixed at 160 mV and 360 mV, respectively. Peak current increases linearly with concentration of dopamine and paracetamol," Dr Peter explains.

The performance of electrode using platinum doped cerium oxide and cuprous oxide is better than the cerium oxide–graphene material, as found by the researchers.

Next, the team is going to target multiple biomolecule detection using the nanocomposite and to get into real-time device fabrication.

IIT-B: Sniffing out lung cancer, explosives

Researchers at the Indian Institute of Technology (IIT) Bombay have set the stage to possibly sniff out in about a minute early-stage lung cancer from exhaled breath. A two-member team led by Chandramouli Subramaniam from the institute's Department of Chemistry has developed a platform that detects volatile organic compounds such as benzene, acetone, benzaldehyde and ethanol in a gas phase at single molecular levels. These organic compounds in exhaled breath are clinically established biomarkers for early stage lung cancer. The same platform can also be used to monitor air-pollution levels or detect explosives like TNT (trinitrotoluene).

The volatile compounds have been detected using lab samples and clinical applications for detecting early-stage lung cancer will become possible once validated on human subjects. The results were published in the journal ACS Sustainable Chemistry and Engineering.

Raman scattering

Since Raman scattering is an inherently weak phenomenon, the researchers turned to surface-enhanced Raman scattering to dramatically increase the sensitivity of the platform such that it detects molecules at extremely low concentrations using a small amount of sample. “In our studies, we were able to reliably achieve sensitivities to the level of tens of molecules,” he says.

“We put the molecule of interest on a gold or silver nanoparticle and then record the Raman spectrum. When we shine light [laser] on the sample [molecule plus the nanoparticle], the Raman spectrum of the molecule gets enhanced,” says Prof. Subramaniam. “The intensity enhancement of Raman spectrum happens predominantly through the interaction of localised electromagnetic field on the nanoparticles surface with the vibrational modes of the molecule.”

The Raman spectrum intensity increases tremendously — 10,000 million times — and this allows the detection of molecules at very low concentration.

Scientists across the world have so far been unsuccessful in applying surface-enhanced Raman scattering to reliably detect molecules in gas or vapour phase.

In the case of molecules present in liquid phase, the addition of the liquid to nanoparticles allows the molecules to get adsorbed on the nanoparticle. Once adsorbed, the Raman spectrum gets enhanced. But capturing the molecule and adsorbing it on the nanoparticle has proven to be difficult when the molecule is in a gas phase.

“This is what we have solved using out technique,” he says. The challenge was overcome by designing nanoparticles that behave as a cage to capture the molecule from the gas phase.

When liquid containing the nanoparticles is subjected to a thermal gradient (one end is kept hot while the other is cold) the nanoparticles tend to migrate from the hot end to the cold one. As a result, the concentration of nanoparticles at the cold end increases. When the concentration of nanoparticles at the cold end increases they self-assemble to form the cage. The cage then traps the molecule, whether it is in a liquid or gas state. “Once the molecule gets trapped, the Raman spectrum gets enhanced as the cage is made of nanoparticles,” explains Prof. Subramaniam.

“Since we don’t use any chemical or lithography to bring the nanoparticles together, there is minimal interference to the signal. So we were able to

detect the analyte [chemical substance of interest] even when only few molecules of it were present," says Maku Moronshing from IIT Bombay and first author of the paper.

Validation of platform

Since testing the technique on human subjects for early-stage lung cancer detection is riddled with ethical and clinical challenges, the researchers looked at low-hanging fruit. This platform is particularly suited for the detection of plastic explosives such as TNT and RDX.

To detect the presence of explosives, air sample containing the molecules is forced into water that contains nanoparticle cages; the molecules get trapped in the cages. The presence of molecules is detected by shining laser and measuring the Raman spectrum. The entire process of sample collection and signal acquisitions takes about 2-3 minutes.

"As each molecule has a characteristic signature, the presence of the molecule in the sample tested can be ascertained by looking for specific signatures," Prof. Subramaniam. "Unlike in the case of early-stage lung cancer, validation for explosives and air-quality monitoring will be easy as no ethical clearances are required."

The researchers are now looking at incorporating data analytics into the platform to make the system to read the signatures automatically. And they are also trying to reduce the size of the platform to make it portable. "We are talking to companies to build miniaturised Raman spectrometers so that this detection technique can be truly portable and field-deployable," he says

Can we repair damaged retina like zebrafish do?

In stark contrast to mammals, the zebrafish has the ability to completely regenerate its retina and restore vision after an injury. Researchers from Indian Institute of Science Education and Research (IISER) Mohali have decoded the signals and genes behind this tremendous feat and hope to uncover valuable clues as to why we humans fail at such regeneration.

A particular signalling system — sonic hedgehog (Shh) — in zebrafish has been previously reported to aid in developmental and tissue regeneration activities. To decipher the influence of Shh signalling on retina regeneration, the researchers first inhibited its function. They found that impairing this signal made 90% of the zebrafish embryo exhibit a birth defect called cyclopia. Cyclopia is also seen in humans, where there is a single median eye or a partially divided eye. Detailed understanding of this signalling may provide insights into the rare defect. Since this signalling is also responsible

for retina regeneration in zebrafish, the researchers are trying to understand why the signalling does not bring about retina regeneration in humans.

They performed whole retina RNA sequencing at various time points post-retinal injury to the zebrafish eye. Several genes (zic2b, foxn4, mmp9) were found to be upregulated through Shh signalling. Zic2b and foxn4 are essential components for development and tissue regeneration, whereas mmp9 is an enzyme which makes the environment congenial for freshly formed cells. Individual knockdowns of these genes also revealed that these are indeed essential for normal retina regeneration.

The researchers also showed the role of a microRNA (let-7) which is regulated through a particular gene (Lin28a) which allows normal Shh signalling during the retina regeneration process. "During an injury, you need the proliferation of cells that let-7 is capable of blocking. So Lin28a steps in action, clears or scavenges let-7 and allows differentiated cells to be transformed into multipotent stem cells, which aid in regeneration," explains Rajesh Ramachandran from the Department of Biological Sciences at the Institute and corresponding author of the work published in the journal Cell Reports.

Mice models

They further carried out studies on mice models by injecting the protein. "Shh protein can easily bind to its respective receptor and turn on the signalling pathway after an acute retinal injury," says Simran Kaur, PhD scholar and first author of the work. "Though there was increased proliferation and upregulation of the genes, no regeneration of the retina was seen in mice."

"Although we have understood the signals and genes behind the regeneration, the whole pathway and network need to be unravelled before trying it out in the mammalian system," adds Prof. Rajesh.

Organophosphorus pesticide detection gets simpler

Using metal-organic framework (MOF) made of cadmium chloride and synthesised under ambient conditions, a research team has been able to detect organophosphorus pesticides such as azinphos-methyl, chlorpyrifos, and parathion both in water solution and in apples and tomatoes. The MOF is highly sensitive such that the presence of pesticides as low as in parts per billion (ppb) can be detected.

The team led by Dr. Partha Mahata from the Department of Chemistry at Jadavpur University, Kolkata and Dr. Sudip Kumar Mondal of Department of Chemistry, Visva-Bharati University, Santiniketan found that the ability

to detect the three pesticides was unaffected by the presence of surfactants. Surfactants are used to dissolve pesticides in water.

Though currently available methods for pesticide detection are efficient in terms of sensitivity, they have other challenges such as complicated procedure to prepare samples, longer time to analyse samples, need for sophisticated instruments and lack of portability for use infield use.

The researchers synthesised the MOF by mixing cadmium chloride and organic ligand in methanol and water at room temperature. After seven days, a single crystal of MOF is formed; such crystals were used for the study.

The MOF was found to emit intense luminescence at 290 nanometre when excited by light at 225 nanometre. “It is the organic ligand that shows the intense luminescence,” says Dr. Mahata. “The organic ligand is tightly bound to the metal framework and forms a crystalline structure. So loss due to vibration gets reduced and luminescence intensity increases.”

In a paper published in the journal Inorganic Chemistry, the researchers say that traces of pesticides in samples were detected by looking for reduction in the intensity of luminescence when the sample containing pesticide was added. At a concentration of 30 micromolar of azinphos-methyl and chlorpyrifos pesticides, the luminescence intensity reduced (or quenched) by 90% and 52% respectively. There was 49% reduction in luminescence in the case of parathion.

Three factors

“A combination of three factors is responsible for luminescence quenching,” says Dr. Mahata. “When the MOF comes in contact with pesticides, there is energy transfer (resonance energy transfer) from MOF to the pesticides. There is also electron transfer from MOF to pesticides. Finally, pesticides also absorb some amount of light used for exciting the MOF.

In the case of azinphos-methyl pesticide, the MOF was able to detect its presence in water even when the concentration of the pesticide was as low as 25 nanomolar (almost 0.008 mg per litre or 8 ppb). “The sensitivity will be a little less in the case of other two pesticides [chlorpyrifos, and parathion] but it will still be in the ppb range,” he says.

The researchers tested the MOF’s ability to detect azinphos-methyl pesticide in apple and tomato extracts. When 30 micromolar of the pesticide was used, the luminescence quenching or reduction was 71% and 80% in the case of apple and tomato extract respectively. “So, the cadmium-based MOF

can be used as an alternative pesticide sensor in both water solution and sample extracts," says Dr. Mahata.

"We are also planning to develop MOF-based sensors where we can see colour changes in visible region of light. We are currently studying the detection pesticides in many other fruits and vegetables," he says.

Mechanism of colistin resistance in Klebsiella bacteria unravelled

A study carried out in Chennai has found bacteria resistant to colistin drug, a last-line antibiotic, in 51 of the 110 (46%) fresh food samples (poultry, mutton, fish, and vegetables) tested. Though colistin-resistant bacteria have been found in food samples in more than 30 countries, this is the first time researchers in India have looked for and found them in fresh food.

More importantly, the researchers, led by Dr. Abdul Ghafur of Apollo Cancer Institute, Chennai, have for the first time uncovered the mechanism by whichKlebsiella pneumoniae bacteria in food samples develop resistance to colistin.

The mechanism

While mcr-1 gene in E. coli confers resistance to colistin drug, mutations and insertional inactivation in mgrB gene are responsible for colistin resistance inKlebsiella . In the case of insertional inactivation, an external genetic element (called insertion sequence) gets inserted into a normal mgrB gene leading to its inactivation. Once the mgrB gene gets inactivated, the Klebsiella bacteria become resistant to colistin antibiotic.

"In clinical settings, the mcr-1 gene is less significant than the mgrB gene mutations for colistin resistance. This is because most of colistin resistance seen in clinical settings comes from Klebsiella bacteria and not E. coli," says Dr. Ghafur. Theresults of the studywere published in the Journal of Global Antimicrobial Resistance.

The mcr-1 gene is found in the plasmid (a small DNA molecule outside the chromosome) of the bacteria and can easily spread between different types of bacteria thus spreading resistance. However, the mgrB gene is located in the chromosome of the bacteria and so less likely to spread. The researchers have now unravelled how colistin resistance spreads in Klebsiella bacteria despite mgrB gene being confined to the chromosome.

Once the insertion sequence inactivates the mgrB gene and makes the bacteria colistin resistant, the insertion sequence moves out from the chromosome to the plasmid of the bacteria. Once inside the plasmid, the

insertion sequence can easily spread to other bacteria. Once it spreads to another bacterium, the insertion sequence moves from the plasmid to the chromosome where it gets inserted into the mgrB gene making it inactive. "This is how colistin resistance spreads in Klebsiella bacteria even though the mgrB gene is found inside the chromosome," says Dr. Ghafur, technical advisory member of India's national antibiotic policy.

The researchers first identified colistin-resistant Klebsiella in the food samples. Then they looked and found mgrB gene mutation in Klebsiella . "We identified 30 samples with colistin-resistant Klebsiella . Of the 30 samples, six had insertion sequences. This is the first time that mgrB gene mutation and the presence of insertion sequence have been identified in food Klebsiella ," he says. "This finding has remarkable public health significance as colistin resistance inKlebsiella can spread to humans."

Colistin is extensively used in veterinary practices as a growth promoter. The powerful antibiotic kills the bacteria in the animal gut leading to greater absorption of the animal feed thus making the animals grow fat and fast. Up to 70% of antibiotics manufactured in the world are used as a growth promoter in animals.

The extensive usage of colistin in animals leads to generation of colistin-resistant bacteria in poultry and freshwater fish. The use of chicken litter as a manure in agriculture results in the transmission of the colistin-resistant bacteria to vegetables.

There is a greater risk of transmission of colistin-resistant bacteria from fresh vegetables and meat to humans. Though cooking kills the bacteria, the possibility of cross-contamination of the bacteria prior to cooking serves as mode of entry into humans.

"Many countries including China have already banned the use of colistin as a growth promoter. India is now planning a similar ban," he says.

IISc team finds new approaches to kill TB bacteria

Oxidative stress can directly damage the DNA, proteins and lipids of most of the bacteria and eventually kill them. However, disease-causing bacteria have evolved mechanisms to survive such stressful conditions. One of the ways bacteria overcome oxidative stress is by condensing or compacting the DNA (nucleoid). Compacted DNA has reduced surface area and hence lower vulnerability to oxidative stress.

The role of several nucleoid-associated proteins produced by bacteria in condensing the DNA is also well known. But for the first time a protein (WhiB4) that condenses the DNA of TB-causing bacteria in response to

oxidative stress has been found by a multi-institutional team led by Prof. Amit Singh from Indian Institute of Science (IISc), Bengaluru.

“Though the role of proteins in condensing DNA and the connection between DNA compaction and bacteria’s ability to survive oxidative stress are already known, this is the first time the role of a protein to condense DNA upon directly sensing oxidative stress in any bacteria has been reported,” says Prof. Singh. Theresults were publishedin the journal Redox Biology .

While DNA compaction helps the bacteria survive stressful conditions, the compaction has to be only for a brief period and should be reversible. Prolonged compaction could adversely impact bacterial multiplication, conversion of DNA into RNA, and formation of protein molecules.

WhiB protein action

The active form of WhiB4 protein is produced in the presence of oxidative stress leading to compaction of TB bacterial DNA. The protein level reduces after a while and thus preventing long-lasting condensation, and also allows the compacted DNA to revert to its original state. “We found the WhiB4 protein was helping the TB bacteria to persist within the host when exposed to stressful conditions,” says Dr. Manbeena Chawla, from IISc and one of the first authors of the paper.

Since prolonged DNA compaction would be detrimental to the bacteria and would eventually kill them, the researchers turned to genetic engineering to replace the promoter of the WhiB4 protein with another one that can be artificially regulated. (The promoter has to be active for a protein to be produced.) “Using extremely low dose (about 100 nanograms) of tetracycline drug we were able to artificially activate the promoter, which kept the WhiB4 levels elevated and guaranteed permanent DNA condensation,” says Dr. Saurabh Mishra from IISc and another first author of the paper.

“This was a proof-of-concept study to show that artificially elevating the levels of WhiB4 protein led to prolonged compaction of DNA leading to bacterial death which is oxidative stress dependent,” says Dr. Kushi Anand from IISc and another first author of the paper.

Two approaches

TB bacteria found inside human cells (macrophages) can be killed using two different approaches. One is to identify the negative regulator of WhiB4 protein and then developing an inhibitor against this regulator. The inhibitor will facilitate the production of WhiB4 protein in excess for a long time leading to long-lasting DNA compaction causing TB bacteria death. “But we

don't know if there are one or more regulators of WhiB4 protein. Many times bacteria have multiple layers of backup system," Prof. Singh says.

The second approach is to use a drug or an inhibitor specific to TB bacteria that directly causes DNA compaction for a long time leading to bacteria death. "Small molecules that compact E. coli DNA for extended period causing death has already been shown," Prof. Singh says.

In any bacteria there are two pathways — production of antioxidants and DNA condensation — that help protect the bacteria from oxidative stress. In2012 studyin Molecular Microbiology, a team led by Prof. Singh had shown that WhiB4 protein is responsible for production of antioxidants. The latest study shows the role of WhiB4 protein in regulating DNA condensation. Thus, WhiB4 protein plays a crucial role in protecting TB bacteria from oxidative stress.

Finding drugs that can either keep the WhiB4 protein level high or DNA condensed for a long time might be challenging. Particularly, as the drug has to cross the macrophage barrier and get inside the infected cell and then enter the TB bacteria. Alternatively, viruses that infect TB bacteria can be used as vehicles to carry WhiB4 protein into the bacteria. Here, the WhiB4 protein from TB bacteria genome has to be amplified and cloned into the virus genome.

These viruses specifically target TB bacteria and so human cells will be spared. But like in the case of the drug, the virus with the WhiB4 protein in its genome has to cross the macrophage barrier to get inside the infected cell before infecting the TB bacteria. And that will again be a challenge.

IISER Bhopal strike at the root of head and neck cancer growth

Researchers at the Indian Institute of Science Education and Research (IISER) Bhopal have found that depleting the production of a specific protein kinase (p21-activated kinase 2 or PAK2), which is normally produced in excess in head and neck cancer, affects a chain of events that finally reduces the growth of head and neck cancer.

In cancer cells, the PAK2 protein is responsible for increased cell proliferation, cell migration, invasion into the extracellular matrix, colony formation and even resistance to certain cancer drugs. The team led by Prof. Sanjeev Shukla from the Institute's Department of Biological Sciences found the PAK2 protein was produced in excess (overexpressed) in 24 of 26 human cancer samples.

Interfering with PAK2

When the production of this protein was reduced in three head and neck cancer cell lines, the cancer cells became less viable and had reduced ability to proliferate, migrate, form colony and even resist cancer drugs. These studies showed the importance of interfering with PAK2 protein levels to control head and neck cancer. So, the researchers set to find the molecular mechanism behind the role of PAK2 protein in cancer growth.

"What we found was when the PAK2 protein level was reduced, the activation of a certain (beta-catenin) signalling pathway was inhibited," says Prof. Shukla. This pathway is important as its activation is associated with downstream target genes that play an important role in cancer growth. "So we hypothesised that the beta-catenin signalling might be dependent on PAK2 protein level and inhibiting the pathway will affect the expression of a well-known cancer gene c-Myc," he says. The c-Myc gene is produced in excess in head and neck cancer and is responsible for cancer cell growth.

"When we depleted the amount of PAK2 protein in cancer cells we found the activity of the signalling pathway getting affected, which then led to reduced expression of the cancer gene," says Amit Gupta from the Institute's Department of Biological Sciences and first author of a paper in the journal Cell Death & Disease.

Cascade of events

In a cascade of events, the reduced expression of the cancer gene causes a reduction in the amount of cancer-specific metabolic enzyme PKM2 produced. The PKM2 enzyme plays an important role in increasing the rate at which the glucose gets converted into lactate in cancer cells, which provides energy and also supports rapid cell division by providing the building blocks for forming new cells. So any reduction in the PKM2 level severely compromises cancer cells' ability to proliferate and migrate.

Unlike in normal cells, the glucose metabolism is not complete in cancer cells. So the glucose gets converted into lactate leading to less energy availability in cancer cells. Cancer cells tend to compensate for this by increasing the rate of glucose to lactate conversion and also by taking up more glucose from the surrounding environment.

"The involvement of PAK2 protein in other cancers is already known. But the cascading effect of PAK2 depletion in compromising the expression of the cancer gene (c-Myc) and cancer-specific metabolic enzyme (PKM2) was not known," says Prof. Shukla. "This is the first study to report this and its role in head and neck cancer progression."

"It might be possible to develop inhibitors to target the PAK2 kinase to help treat head and neck cancer. More studies are needed before inhibitors are used but there is a potential," says Prof. Shukla.

"The PAK2 protein is also responsible for chemotherapeutic resistance. So it might be possible to enhance the efficacy of currently available cancer drugs by combining them with PAK2 inhibitors," says Gupta.

Mcr-1 gene seen in K. pneumoniae bacteria

Increased prevalence of mcr-1 gene that confers multidrug-resistance has now been reported in Klebsiella pneumoniae bacteria, increasing the fear of infection by pan drug-resistant bugs. This gene endows resistance against last hope antibiotic — colistin. A study published in Antimicrobial Agents and Chemotherapy found that about 10% of the K. pneumoniae bacteria studied were resistant to colistin.

During January–February 2016, a total of 200 K. pneumoniae isolates from pus, blood, sputum, and urine were studied. Of this, 21 were resistant to colistin, and further screening revealed that four harboured mcr-1 gene.

"This gene was first reported in December 2015 in E. coli isolated from chicken in China, and by 2017 it had spread to all continents and [is] seen in bacteria isolated from humans, chicken and environment," says Prof. Kashi Nath Prasad from the Department of Microbiology at Sanjay Gandhi Postgraduate Institute of Medical Sciences, Lucknow, and the corresponding author of the work. "Evidence suggests that the overuse of colistin in farm animals has given rise to the emergence of mcr-1 gene. Since this gene is present on a mobile genetic element (plasmid) of bacteria such as E. coli and K. pneumoniae, the frequency of transmission to other bacteria is likely to be very high."

Molecular studies revealed that one particular isolate carried mcr-1 gene and blaNDM-1 gene. "The blaNDM-1 encodes for a protein that gives resistance to all beta-lactam antibiotics. This shows that the particular isolate was resistant to carbapenems, third-generation cephalosporins, aminoglycosides and fluoroquinolones (ciprofloxacin, levofloxacin) making the treatment very difficult," says Sanjay Singh, research scholar at the institute and first author of the work.

Evolved gene

Interestingly, mcr-1 gene was seen in the chromosomal DNA of the bacteria. "The mcr-1 gene is usually found in the plasmid (small DNA in the cytoplasm) and the resistance gene is transmitted among different species. But now we have found this gene in the chromosome showing that it has

evolved and stabilised. Whole genome sequence studies are needed to understand the exact location of this gene to decode how they are transmitted from one bacterial species to another," adds Mr Singh. "The presence of the gene in the chromosome also means that Indian population may be harbouring mcr-1 gene for a longer period of time and it remained undetected."

Further studies by the group also found that mcr-1 gene was more prevalent in K. pneumoniae than E. coli, which is in stark contrast to findings from other countries. While less than 1% of the E. coli studied was resistant to colistin, it was about 10% in the case of Pneumoniae. More studies are needed to understand this contrasting behaviour. The team is also looking for this gene in other bacteria causing human infection and its mode of dissemination.

IGIB team finds a new target to reverse iron overload disease

Using zebrafish, researchers at the Institute of Genomics and Integrative Biology (CSIR-IGIB) have successfully discovered a pathway that regulates hepcidin hormone production. The hepcidin hormone, released by the liver, is a central regulator of iron in the body. Dysregulation of the hormone leads to anaemia on one hand and excess iron accumulation in organs such as liver and heart leading to multi-organ failure.

Hemochromatosis is a rare hereditary disease that is characterised by iron accumulation or overload in various tissues. The symptoms are non-specific and hence difficult to diagnose. Current options only manage the disease by removing excess iron. "One method is to bleed the patients and the other is to absorb iron using iron chelation, which is toxic to liver and kidney and may also cause hearing problems. There is no therapy currently available," says Sandeep Basu from CSIR-IGIB and first author of a paper published in ACS Chemical Biology.

Gene mutations

Mutations in about six genes are known to cause reduction in hepcidin hormone production thereby causing excess iron accumulation. But for the study, the research team led by Chetana Sachidanandan created a disease model in zebrafish by mutating one of these genes (TFR2). Mutations in the TFR2 gene cause a severe form of the disease.

The zebrafish with the mutant gene showed excess iron accumulation in organs, quite similar to what is seen in humans.

In the conventional drug discovery approach, the target protein and even the pathway are already known and molecules that would either inhibit or

overproduce the target protein are screened for. But the researchers adopted a different approach for this study.

"Hepcidin gene is controlled by many factors, many of them not well understood. So, instead of picking one target for our drug screen, we focused on the symptoms of the disease — excess accumulation of iron," says Dr. Sachidanandan. "We knew that hepcidin hormone is low in the hemochromatosis patients, and that this causes iron overload."

Since the researchers knew hepcidin production is regulated by many signalling pathways, they selected 80 compounds that specifically target signalling pathways in zebrafish. Of the 80 compounds tested, eight were found to induce the production of hepcidin hormone in the fish. "One of these compounds is a blocker of NFkB signalling pathway. This pathway was not known to be important in hepicidin regulation in the liver." This is the first time that researchers have been able to identify and tell that the NFkB pathway regulates liver hepcidin production.

Unbiased strategy

"It was not a blind screening, but rather we used our existing knowledge about hepcidin regulation. When we don't have a deep understanding of a disease, but need to discover drug candidates, this kind of unbiased strategy is more efficient," she says.

The researchers tested the ability of this compound to regulate hepcidin production. "The small molecule targets and inhibits the NFkB pathway signaling thus increasing hepcidin production and reducing iron overload," says Basu. They tested three more compounds that target the same pathway to confirm that the NFkB pathway is indeed a key to regulating hepcidin production. "There are other signalling pathways that regulate hepcidin production but our discovery places NFkB pathway as an important negative hepcidin hormone production," Basu says.

When the pathway in the zebrafish model of Hemochromatosis was inhibited using the four compounds, the hepcidin production was restored and iron overload was reduced, thus reducing the severity of the disease.

To further reconfirm the role of the NFkB pathway, the researchers removed it in zebrafish. This led to overproduction of hepcidin hormone in the fish, confirming that the pathway negatively regulates the production of the hormone.

None of the four compounds tested in zebrafish is approved for use in humans; one compound tested is approved for use in poultry. "The target pathway has been identified even though the tested compounds cannot be

used as drugs. What is important is that we have found a strategy for therapy," says Dr. Sachidanandan. "Now that we know the pathway to be targeted, it's easier to discover drug molecules."

"We are now working to see if we can apply this therapeutic strategy for Thalassemia patients," Basu says.

4. Computer and IT

'World's largest mobile factory' now in Noida

With this plant, set up on an investment of Rs. 4,915 crore, the South Korean electronics major plans to make India an export hub, with 50% of its overall production coming from here in the next three years from the present 10%.

Speaking at the event, Mr. Modi said the government's 'Make in India' initiative was not just an economic policy measure, but also a commitment of better ties with friendly nations like South Korea. He added that 30% of the phones made at the Noida plant would be exported.

Mr. Modi, who travelled with Mr. Moon to Noida in the Delhi Metro, said India's growing economy and rising neo-middle class created immense investment possibilities.

The move comes at a time when companies globally are seeking to grab a pie of the exploding smartphone market in India, which is the world's fasted growing smartphone market, where shipments grew 14% to 124 million in 2017, as per IDC. It overtook the U.S. last year to become the world's second-largest smartphone market after China.

All Samsung mobile phones, including the flagship Galaxy S9, S9+ and Galaxy Note8, are made at the Noida plant.

Aujas opens centre to help foil cyberattacks

Aujas Networks, a cybersecurity firm whose customers include Japanese financial services group Mitsubishi UFJ and a domestic national identity programme, has opened a 'Security Operations Centre' that will help detect and respond to complex threats in real time.

The Bengaluru-based facility would host a team of certified security professionals who would scan clients' networks for suspicious behaviour round-the-clock. Threat data collected from the external landscape would be

combined with information to identify risks and recommend rule changes to pre-empt future attacks.

The Indian Computer Emergency Response Team (CERT-In) reports that in 2017 more than 53,000 cybersecurity incidents were observed: these include phishing, website intrusions, ransomware and denial of service attacks.

"The key question is do you want your security teams to play on the back foot and wait for malicious attacks or should they start playing on the front foot and stop an attack before it happens," Srinivas Rao, co-founder and CEO of Aujas, said. Citing an example of a bank or an insurance services provider, Mr. Rao said a network breach could potentially endanger a customer's assets as well as personal data and business reputation.

Centre upholds Net neutrality

A separate committee has been set up under the DoT to examine what these critical services will be. These may include autonomous vehicles, digital healthcare services or disaster management. The regulator, in November 2017, batted in favour of Net neutrality.

The regulator had said, "Internet access services should be governed by a principle that restricts any form of discrimination or interference in the treatment of content, including practices like blocking, degrading, slowing down or granting preferential speeds or treatment to any content."

This principle, it had added, would apply to any discriminatory treatment based on the sender or receiver, the network protocols, or the user equipment, but not to specialised services or other exclusions. It had also said that these would not apply to "reasonable traffic management practices" by the service provider. India's decision to uphold Net neutrality assumes greater significance given that in the U.S., the rules on Net neutrality were repealed. The decision, which came into effect in June, paves the way for service providers to block or slow down access to particular content for users.

To implement Net neutrality, the regulator had recommended that the terms of licence agreements that govern the provision of Internet services in India be amended "to incorporate the principles of non-discriminatory treatment of content along with the appropriate exclusions and exceptions." The regulator has recommended establishing a multi-stakeholder not-for-profit

body for the monitoring and enforcement of the principles. Besides, the Telecom Commission also gave its approval to the new digital communications policy 2018 (new telecom policy), which will now be sent for Cabinet approval.

The policy, unveiled in May this year, aims to attract $100 billion investments into the country's digital communications sector, provide broadband access for all with 50 mbps speed and create 40 lakh new jobs in the sector by 2022.

The Commission also gave its nod to install 12.5 lakh Wi-Fi hotspots in all gram panchayats.

Quantum computers have an edge over classical ones, says the oracle

Computing may itself be a complex world for many, but classical computational complexity is an area literally booming with research. Quantum computers add a new dimension to this field in the form of quantum complexity. Now, a major problem concerning quantum computing has been settled by Ran Raz, professor at Princeton University, and Avishay Tal, now a post-doctoral fellow at Stanford University. "The quantum complexity world is rocking…" writes Lance Fortnow, Professor of Computer Science at Georgia Institute of Technology, in his blog, referring to the splash made by a paper posted online on May 31 in the Weizmann Institute website.

Now what could be so exciting? It's a complex story that begins with complexity classes. First, computing problems have degrees of hardness associated with them. The class in which you place a problem is related to the efficiency of the algorithm used to solve it, namely, the number of operations a computer must make to arrive at the solution.

Think of a set of Russian Matrioshka dolls: the biggest doll contains a smaller one which in turn contains a smaller one and so on. The hierarchy of complexity classes can be viewed as a set of Matrioshka dolls.

The smallest doll here is the set P of problems for which there are known efficient, 'polynomial time' algorithms. One such example is matrix multiplication. As the size of the matrices increase, the time taken to multiply them using a classical algorithm increases as a polynomial function of the size of the matrices. Linear programming is another problem in P.

A larger doll containing P is the set NP. While algorithms that solve problems in NP are not yet known, efficient algorithms that can verify whether a

proposed solution is a correct answer do exist.A typical problem in the NP class is a version of the travelling salesperson problem: Given pairwise distances between 'n' cities, we ask if there is a route to visit every city just once so that only 'L' litres of petrol are spent.

A still larger doll, or a class that contains all the above-mentioned classes, is PH, which stands for polynomial hierarchy.

Complexity crunch

The analogy of Matrioshka dolls must be taken carefully though, because it is still not known whether the problems in NP have efficient algorithms that can solve them. Hence, whether P equals NP is an open problem. Indeed, it is a millennium problem in the Clay Institute's list. If someone shows that the classes all have polynomial time algorithms, there could be a great complexity crunch!

Into this hierarchy of Matrioshka dolls comes the class BQP which consists of all the problems that can be solved efficiently by a quantum computer. For 'efficiently' read 'in polynomial time'.

The question is will this class BQP fit into the classical hierarchy or will it be disjoint? In the analogy of Matrioshka dolls, will it have a different shape, so that it won't fit in somewhere in between the class PH and NP?

An outright answer to this question is difficult, but scientists invoke the concept of an oracle. An oracle is a device that will give an answer to a query about the solution of the problem – like the master gives answers in a 'twenty questions' game. The more the number of queries posed to the oracle, the more the 'time' taken to solve the problem.

Quantum and tractable

Raz and Tal invoke an oracle, in the presence of which they have shown that there are problems in BQP which are not in PH. Using clues provided by an oracle, some problems in BQP can be solved in polynomial time. Even with the clues, the problems would take much, much longer on a classical computer. This is called an 'oracle separation' between BQP and PH.

This is a big result because, as Raz puts it, "Our result shows that relative to some oracles, for some computational problems, quantum algorithms are more efficient than the entire classical polynomial hierarchy." Alternatively, as Lance Fortnow explains in his blog, this result can be seen "as an indication that even in a world where P=NP (and even if integer factoring is easy), quantum algorithms might still have an edge over classical computation," explains Tal in an email.

The duo uses a concept called 'forrelation' that was introduced by computer scientist Scott Aaronson of University of Texas at Austin, in the context of this very problem, a few years ago.

At a talk at Stanford's theory seminar in May 2018, computer scientist Pooya Hatami described his recent work on pseudo-random generators, jointly with Chattopadhyay, Hosseini and Lovett, and something clicked. "One lemma drew my attention and I thought about it for a few days, looked at the proof, and tried to understand its power. I then realised that this is exactly what we were missing," says Tal.

"The Raz and Tal work is a great theoretical result, solving a 25-year-old problem in quantum complexity theory," says V Arvind, complexity theory expert and director of Institute of Mathematical Sciences, Chennai.

"It is not clear to me if we can infer something new from this result about the power of quantum computing in practice. A similar result showing an oracle separation of BQP from NP was shown several years ago, using much simpler techniques. And anything practical we might want to infer is already implied by the earlier result," he adds.

New telecom policy aims to provide broadband access to all citizens by 2022

The Union Cabinet approved the new telecom policy that aims to provide broadband access to every citizen at 50 Mbps speed by the year 2022.

The National Digital Communications Policy 2018, which envisions attracting $100 billion investments into the country's digital communications sector, aims at creating at least 40 lakh new jobs in the sector in the next four years.

Evolving at rapid pace

"The last telecom policy was announced in 2012... The communication sector has been evolving at a rapid pace globally, especially with technologies such as 5G and Internet of Things. There was a need for a new consumer-centric and application-centric policy," Minister for Communications Manoj Sinha told the media.

The policy aims at expanding the IoT ecosystem to five billion connected devices, create globally recognised IPRs in India and create a fund for R&D in new technologies. It also pitches for leveraging Artificial Intelligence and Big Data to enhance the quality of services offered, spectrum management and network security while also establishing India as a global hub for cloud computing. Welcoming the much-awaited policy, the industry called for a

close monitoring of its timely implementation "so that the industry can recuperate from the deepening financial stress." "Thus, the most important and urgent requirement is to restore the financial health of the sector for which the policy document envisages the reduction in levies and ease of doing business. This will help the industry in achieving the goals of and fulfilling the objectives outlined in the policy," said Rajan S Mathews, DG at industry body COAI.

The policy has called for a review of levies and fees — including licence fee, universal service obligation fund levy and spectrum usage charges, on the sector. This is expected to help the debt-laden telecom sector. However, the government may take up to a year to decide on these issues the Minister said in response to a query.

Govt. unveils centre for data analytics

With a view to fast-tracking the adoption of data analytics in the government to improve delivery of services to citizens, Electronics and IT Minister Ravi Shankar Prasad unveiled a Centre of Excellence for Data Analytics (CEDA).

The centre would help build analytic solutions that are specific to a particular problem which may relate to a single or a combination of departments, an official statement said.

It added that the centre would also provide data profiling tools and techniques along with necessary expertise to analyse the data for quality issues.

Improve data collection

"While data cleaning shall be done for making the data ready for analytical use, recommendations shall also be given in order to help the department take necessary actions to further improve their data collection process," it said.

Besides creating the analytics solutions for the government departments, CEDA would also focus on training and enabling the departments to do self-service analytics.

Centre warns against data abuse

The Centre informed the Lok Sabha that it was up to social media platforms to weed out fake news, and it would come down heavily on companies found abusing data to influence elections.

Answering a question, Union Minister for Law and Information Technology Ravi Shankar Prasad said the Centre would seek the States' response to a

proposed data protection law, and it desired an "elaborate discussion" before formulating such a law.

He said the government ordered a CBI probe into the alleged misuse of the data of Indian Facebook users by Cambridge Analytica, a British political consultancy firm. "Any foreign entity, Facebook or Cambridge Analytica, cannot abuse the data of Indians to influence elections in India. Indian elections are very transparent, sanctified."

The government told the social media platforms that fake news or abusive news could not be circulated and re-circulated to "create crimes", Mr. Prasad said. "Therefore, the origin of those news should also be technologically answered. I have made it clear to them that it does not need rocket science to identify lakhs of messages being circulated on a particular day, in a particular area of a particular State. You must have technological solutions."

His comments come within days of rumours on WhatsApp having triggered incidents of lynching.

Mr. Prasad said that while Facebook apologised to the government and said data was pilfered by other agencies, Cambridge Analytica gave just one reply.

Facebook had disclosed that the data of around 5.62 lakh Indians might have been potentially affected in the Cambridge Analytica case. "However, Cambridge Analytica responded that it does not have any Facebook data on Indian citizens. To a second notice, Facebook informed that Cambridge Analytica had violated Facebook's policy. Cambridge Analytica has not responded to the second notice."

He said the government asked the social media platforms to appoint a grievance redress officer in India before whom complaints could be made. "We respect privacy. But privacy cannot be used to shield terrorists and the corrupt," he added.

Indigenous anti-tank missile test-fired

An indigenously developed Man Portable Anti-Tank Guided Missile (MPATGM) was successfully flight tested for the second time from Ahmednagar test range.

It has been developed by the Defence Research and Development Organisation (DRDO).

"All the mission objectives have been met. The two missions on September 15 and 16 have been successfully flight tested for different ranges, including the maximum range capability," the DRDO said in a statement.

This low-weight MPATGM will complement the Spike Anti-Tank Guided Missile to be procured from Israel.

Defence Minister Nirmala Sitharaman congratulated the DRDO team, the Army and associated industries on their success.

New Akash missiles get green light

The Army, which is inducting the indigenously developed Akash short-range surface-to-air missile (SRSAM) system, will get an upgraded variant. The Defence Acquisition Council (DAC) gave its procedural approval to the variant.

The Army has already inducted two Akash regiments, and ordered two more last year after a global tender for the SRSAM was cancelled. The Akash system has since been upgraded, and the DAC has now approved an upgraded variant for the third and fourth regiments.

Advanced features

"The upgraded version will include the seeker technology and possess a 360-degree coverage, and will be of compact configuration. It is an operationally critical equipment, which will provide protection to vital assets," the Defence Ministry said in a statement.

The Defence Research and Development Organisation (DRDO) developed Akash as part of the Integrated Guided Missile Development Programme initiated in 1984. It is made by Bharat Dynamics Limited (BDL). Akash has a range of 25 km and can engage multiple targets at a time in all-weather conditions. It has a large operational envelope, from 30 metre to a maximum

of 20 km. Each regiment consists of six launchers, each having three missiles.

The DAC also gave approval for the development of an individual under-water breathing apparatus for the T-90 tank. The apparatus is used by the tank crew for emergency escape.

India conducts successful interceptor missile test at night

India successfully conducted an interceptor missile test from Abdul Kalam Island in Odisha night, achieving a major milestone in developing a two-layer Ballistic Missile Defence system. The Prithvi Defence Vehicle mission is for engaging targets at an altitude of above 50 km of the earth's atmosphere, a DRDO scientist said.

India, China Armies meet in Ladakh

Amid continuing transgression by China at Demchok in eastern Ladakh, the Armies of India and China held a ceremonial Border Personnel Meeting to mark India's Independence Day.

The meeting was held at Chushul-Moldo and Daulat Beg Oldie. The Indian delegations were led by Brigadier V.K. Purohit and Colonel Anil Kumar Sharma, and the Chinese delegations by Senior Colonel Wang Jun Xian and Lieutenant Colonel Li Ming Ju.

However, not far from the venues, a stand-off has been going on in Demchok since early July when Chinese troops intruded 300 metres into the Indian territory and pitched tents. Official sources said a group of Chinese soldiers entered the area, in the garb of nomads, and pitched five tents. However, four tents were removed within days, after India opened discussions between border commanders under the existing mechanisms.

One tent is still there, and the discussions are continuing, an official source said. The incident comes a year after the 73-day stand-off at the Doklam trijunction.

Transgressions are common along the unsettled Line of Actual Control.

The two countries have instituted several mechanisms to resolve such issues.

However, according to government figures, the number of transgressions by the People's Liberation Army into Indian territory has gone up from 272 in 2016 to 426 in 2017.

ISRO telemedicine nodes for soldiers in high-altitude areas

In a major effort to improve emergency medical support to soldiers posted in high-altitude areas, especially Siachen, the Integrated Defence Staff of the Defence Ministry and the Indian Space Research Organisation (ISRO) signed a memorandum of understanding to set up telemedicine nodes in critical places across the country.

"ISRO will establish 53 more nodes in the first phase over and above the existing 20, in various establishments of the Army, Navy and Air Force across the country," a defence official said.

In Siachen

As part of this, in addition to a functioning node on the Siachen glacier, four more nodes are being established to enable medical consultation between soldiers deployed on the glacier and medical echelons in the rear.

During winter months, many of the remote posts are cut off for several months because of adverse terrain and extreme weather, making emergency evacuation near impossible. Communication through satellite-enabled telemedicine nodes will be a paradigm shift in the delivery of lifesaving health care till the weather clears up and movement is possible.

This joint initiative by ISRO and the Armed Forces Medical Services will transform the reach of telemedicine to soldiers, airmen and sailors in remote and isolated posts, the official added.

Environment and Ecology

Decreasing 'greenness' in India's forests

Most forests are green. But a recent study finds that this 'greenness' is consistently decreasing across more than 46 lakh hectares of various types of forest in India, particularly in core protected areas. This indicates that our forests are vulnerable, write scientists.

India's diverse forests face several threats including forest degradation, as the loss of greenness signifies. Scientists at Hyderabad's National Remote Sensing Centre analysed NASA's MODIS satellite images of India's forests at eight-day intervals for 15 years (2001 to 2014) and assessed the persistent decreases in greenness. Using an index that determines the amount forest "vigour," they assessed the seasonal greenness of 14 different forest types: the negative the trend of greenness over years, the more degraded and vulnerable the forest.

They found that the highest degradation is in moist deciduous forests (more than 20 lakh hectares), especially in the states of Chhatisgarh, Odisha, Maharashtra and Madhya Pradesh. Wet evergreen forests – including those in the Western Ghats and Eastern Himalayas – are also affected, with the major changes observed in Karnataka and Arunachal Pradesh, followed by Kerala and Meghalaya. More than 15% of India's total mangrove forests also showed a decrease in greenness. Nearly 80% of these changes occurred in 'core' forests like protected areas.

Using statistical analyses, the team determined the 'spots'or areas where the decreases in seasonal greenness were high and spatially contiguous. West Bengal was a major hotspot of mangrove degradation. Arunachal Pradesh, Kerala, Karnataka and Meghalaya were hotspots of decreasing greenness of wet evergreen forests while Manipur, Tamil Nadu, Mizoram, Sikkim and Arunachal Pradesh showed degraded montane (high-elevation) wet forests.

According to the authors, the result of this study could provide first-hand information to prioritise and plan conservation of these areas or restore them to their original glory. However, while the study identifies the hotspots where decreasing greenness is a worry, it does not identify what caused this problem.

"This decreasing greenness could be due to natural or anthropogenic factors that we have not identified in the study," said Abhishek Chakraborty, lead author of the study published in Ecological Indicators. "It could be due to changing climates, shifts in monsoon patterns, decreasing soil fertility or the impact of human activities."

Trees offer multiple benefits — don't kill them, breed them

Officials in Delhi wish to fell about 17,000 fully grown trees in some parts of the city to make space for building housing colonies. And to "pacify" people who object to this tree destruction, they say that for every tree that will be felled, they will plant 10 saplings. Interesting — the minister knows it; the National Building Construction Corporation (NBCC) knows it and we all known it — that this is a stupid answer. "What you lose today, I will make up" (20 years from now? and if the saplings survive?) And this is not just in Delhi. Government and city planners in several other states do the same. This attitude shows not just ignorance but arrogance, disregard for trees and their value. It is time planners wake up and understand the value — economic, ecological, health-related and sociological — that trees offer.

Value of a tree

Way back in 1979, Dr. T.M. Das of Calcutta University estimated that the monetary value of a tree, during a life span of 50 years, amounted to about $2,00,000 (at 1979 rates). This was based on the amount of oxygen it produces, the fruit or the biomass and the timber it offers when felled and so on. For every 1 gram that a tree accumulates as it grows, it generates about 2.66 grams of oxygen. Dr Nancy Beckham of Australia, in her paper, "Trees: finding their true value", points out that "trees and plants silently carry out their daily routine years after years, stabilizing the soil, recycling nutrients, cooling the air, modifying wind turbulence, intercepting the rain, absorbing toxins, reducing fuel costs, neutralizing sewage, increasing property values, promoting tourism, encouraging recreation, reducing stress and improving personal health as well as providing food, medicine and accommodation for other living things".

The Department of Environmental Conservation of New York State, USA offers numbers in this connection (see <http://www.dec.ny.gov/lands/40243.html>), along with references to scientific papers which estimate these numbers. It points out that (1) healthy trees mean healthy people: 100 trees remove 53 tons of CO2 and 430 pounds of other air pollutants per year; (2) healthy trees mean healthy communities: tree-filled neighbourhoods lower the levels of domestic violence and are safer and move sociable; (3) healthy trees mean healthy environment — 100 mature trees catch about 1,40,000 gallons of rain water per year; (4) healthy trees mean home-owner savings — strategically placed trees save up to 56% of air conditioning costs; evergreens that block winter winds can save 3% on heating; (5) healthy trees means better business — in tree-lined commercial districts, shoppers report more frequent shopping and spend 12% more for goods, and (6) healthy trees means higher property values.

The minister and the NBCC officials are smart people and they surely know all these facts. Yet for them, a mature tree is "dead urban space" and clearing 17,000 trees means real estate for building houses, colonies and shopping malls in a city that is gasping for clean air. (Delhi Greens, an NGO, estimated in 2013 that a healthy tree is worth Rs. 24 lakh a year, just with respect to its oxygen producing capacity). And for them a sapling occupies (today) about a hundredth (or even less) space. But where will they plant the saplings — where the trees were? How will they survive if construction starts already? Clearly the officials' attitude is: 'well, we will be gone (transferred/ retired) and do not need to answer'. What Gurgaon was then, and is now, makes the point.

Admire trees, don't axe them

In stark contrast to their cruel attitude towards trees stand the examples of Sunderlal Bahuguna's "chipko" movement, Saalumarada Thimmakka of Karnataka who has planted 398 banyan trees — each representing her own child, and Majid Khan and the team of biologists and horticulturists who are offering "intensive care" (injecting insecticide mix in to the phloem of each branch) to a 700 years old "pillalamarri" banyan tree near Mahabubnagar, Telangana, spanning a 4–acre canopy , which is being eaten up by termites, and bringing it back to life. (See: https://www.thehindu.com/news/national/telangana/a-tree-in-intensive-care/article24241462.ece). Should it have been cut and the 4 acre space used as real estate?

Obviously trees offer emotional, even spiritual solace. Indian history is replete with examples — Lord Buddha, Emperor Ashoka, and the Tamil King Pari Vallal who left his chariot near a plant to help it spread its branches.

Should not Delhi then think of building houses and colonies elsewhere in the suburbs, saving these 17,000 trees? Or if at all it has to do it in Delhi, think new thoughts, but without cutting the trees (or at best sacrificing the smallest possible number)? This impossible-sounding scheme offers challenges to architects. Indeed, high rise apartments have been built elsewhere, saving trees and even including them as part of the building. Some examples are seen in Italy, Turkey and Brazil.

India has been blessed with creative architects, both Indian and foreign, who have built houses and campuses, totally in harmony with the surroundings. The Indian Institute of Architects has about 20,000 members, we have about 80 institutions that teach architecture. Why not throw a challenge to them to come up with the best plan, offer a handsome award to the most suited and creative one, and use it to build the colony?

Human population, roads reduce effectiveness of protected areas

Designated protected areas such as wildlife parks and sanctuaries are effective at preventing forest loss — except when there are roads or more populous areas nearby, find scientists.

Loss of forests is a worry in most tropical countries including India which is home to the Western Ghats, one of the world's major biodiversity hotspots. To assess trends of forest loss in the Ghats, a team including Meghna Agarwala from Ashoka University, analysed high-resolution Landsat satellite imagery from 2000 to 2016. The teamexamined whether the forest loss

correlates with factors including protection status of an area (protected area PA, versus non-PA) and proximity to roads and towns. They collected biophysical (slope, elevation etc, which play a role in patterns of forest loss), demographic (human population densities from census data) and administrative (protection status of an area) data from multiple sources, incorporating this into their spatial analysis.

The results, published in Biological Conservation, show that forest loss — though confined to only small patches — are higher in wetter areas, higher altitudes and near rivers and lakes across 89,681 sqkm of forests in the Ghats. Protected areas were 30% less likely to lose forest than non-protected areas, especially when forests were closer to roads and towns. However, the advantage of protection declined by 32% when local population densities increased.

"Interestingly, we found that the benefits of protection can be modulated by how close a forest area lies to a road or how dense the surrounding human populations are," writes co-lead author Meghna Krishnadas of Yale University, U.S., in an email to The Hindu. "In the case of roads and protection, we found that protection reduced forest loss, but the benefit of protection diminished if the forest patch was within 4 km of a road."

However, the results varied when the team analysed two smaller landscapes in Karnataka, hinting that local factors are important mediators of forest loss patterns. This could include how locals use forests in their vicinity and working with communities could improve long-term forest conservation, adds Ms. Krishnadas. 0"Larger studies like these can help scientists explore local degradation near roads," says scientist P. Jeganathan of the Nature Conservation Foundation who was not part of the study but has studied wildlife roadkills in the Ghats. "It would have been interesting to explore how other linear infrastructure — like powerlines or canals — also impact forest loss. Translating this into policy would be crucial," he adds.

India to expand polar research to Arctic as well

Three decades after its first mission to Antarctica, the government is refocusing priorities to the other pole — the Arctic—because of opportunities and challenges posed by climate change.

This month, it has renamed the National Centre for Antarctic and Ocean Research (NCAOR) — since 1998, charged with conducting expeditions to India's base stations to the continent — as the National Centre for Polar and Ocean Research.

It's also in talks with Canada and Russia, key countries with presence in the Arctic Circle, to establish new observation systems, according to a source. Now, India only has one Arctic observation station near Norway.

"The renaming has been approved," says a July 5 notification by the Ministry of Earth Sciences.

More expeditions

While annual missions to maintain India's three bases in Antarctica will continue, the new priorities mean that there will be more expeditions and research focus on the other poles, the source said. M. Rajeevan, Secretary, Earth Science Ministry, wasn't available for comment.

Climate change, said the source, person familiar with deliberations, was a decisive factor in India re-thinking priorities. Sea ice at the Arctic has been melting rapidly — the fastest in this century. That means several spots, rich in hydrocarbon reserves, will be more accessible through the year via alternative shipping routes. India is already an observer at the Arctic Council — a forum of countries that decides on managing the region's resources and popular livelihood and, in 2015, set up an underground observatory, called IndARC, at the Kongsfjorden fjord, half way between Norway and the North Pole.

Average sea levels may rise by up to 30 ft on global warming, says study

Average sea levels may rise by up to 30 feet around the world if humans continue to burn fossil and fuels causing temperatures to breach the threshold of 2 degrees Celsius above pre-industrial levels in the next few thousand years, says new research.

The Paris Agreement requires countries to limit their carbon emissions to keep the overall warming of Earth to 1.5 degrees Celsius above pre-industrial levels.

With over a billion people living in coastal zones around the world, the impact of rising sea levels on human population along the coast could be larger than expected, especially in poor and developing countries, where millions are directly or indirectly depended on the oceans for their livelihood.

Demonstrating the co-relation between the cumulative carbon emissions and future sea-levels over time, the new study published in Nature Climate Change also raises concerns over the impending economic losses in the world's largest coastal cities due to coastal flooding.

"The sea level rise we have seen thus far is just the tip of a very large iceberg. The big question is whether we can stabilize the system and find new energy sources. If not, we are on the way to a slow-motion catastrophe," said co-author of the study Alan Mix from Oregon State University.

Researchers highlight that at present, over 10 billion tonnes of carbon is being emitted globally, which would mean that the 2-degree threshold would probably be reached within next 60 years.

According to oceanographers, among South-Asian countries, Bangladesh is most-vulnerable, but India with its vast coastline of nearly 7,516 km on the east and west also needs to be proactive, considering the vast numbers of people who are dependent on the oceans for their livelihood.

According to studies conducted, the sea-level is rising at an average rate of 1.6-1.7 mm per year along the Indian coast, but it is not uniform.

"It varies from 5mm in Sunderbans to less than a 1 mm per year in some of the areas in the west coast. Sunderbans are most vulnerable, not only because its low-lying, but also because the land is also sinking," said S C Shenoi, director, Indian National Centre for Ocean Information Services, Hyderabad.

Scientists and researchers have prepared a vulnerability index of the entire coast of India, which not only covers threats due to sea level rise but also Tsunamis.

"Rising sea levels have not really alarmed people yet because their response time is much longer than temperature. Smart countries will use that to their advantage and begin adaptation strategies over time," said Peter Clark, lead author from Oregon State University, emphasizing the need to consider the rise in sea levels as important factor while making future policy decisions on limiting carbon emissions.

"The sea levels are the highest ever globally. Though it is expected to rise by less than a metre by the end of this century, but even that is crucial, especially for India where places like Mumbai, could face consequences as happened in 2005," said S W A Naqvi, former director, National Institute of Oceanography (NIO), Goa.

However, Naqvi highlights that the climate change will not just lead to rise in sea-levels, but is set to affect storminess in the seas, which is a significant concern. "Most importantly, it is not just the rise in sea levels, but when coupled with storm surges, rising tides which can cause maximum damage in terms of inundation of low-lying areas. There are areas

which are not very high above the sea level, which are at maximum risk," he said.

Researchers point to the urgent need to prepare the coastal cities for the looming threat, especially considering the important role they play in powering the country's economy. According to researchers, global economic losses from flooding in 2005 in the world's largest coastal cities had reached $6 billion, which is estimated to grow to $1 trillion by 2050.

A recent study conducted by researchers from Indian institute of Technology Bombay, 'Effect of climate change on shoreline shifts at a straight and continuous coast', throws light on these concerns, while analysing the impacts of climate change on India's coasts in terms of coastal sediment transport, shoreline erosion and overall coastal vulnerability. The study takes into consideration the coast of Udupi in Karnataka along India's western coastline which is one of the rapidly changing coastal stretches, and highlights that the effects of climate change could be worse than expected in terms of erosion along the coastline. "In future, higher waves may occur more frequently with corresponding reduction in the frequency of lower waves," states the research paper.

According to the research, recent analysis of satellite images indicates that the shoreline under consideration is undergoing continuous erosion with an annual average rate of 1.46 m/yr, that the trend of significant erosion noticed in the past will continue in the future as well and that such rate over the next 35 years would go up to 2.21 m/yr. This could be because of the increase in wave forcing in future.

"There are definitely going to be effects on storms due to climate change. We are now focussing on gathering more data and constructing models which can give us accurate projections of estimate sea level rise along the Indian coast. The aim is to prepare maps which can show how much land we will lose. The topography is very important to make that assessment and we are working on that," added Shenoi.

Scientists are also concerned about the fact that the Indian ocean is warming up faster than other oceans. The increased heat content can fuel stronger storms along the coasts, which could be drastic and more areas can face the risk of inundation. Higher waves could occur more frequently.

Even as sea level rise takes a lot longer to respond to global warming, researchers emphasize that the most evident impact could be expected on the coastlines and countries should take that into consideration during policymaking on climate change to safeguard their coasts.

"Keeping sea level rise to 3-9 meters or roughly 10 to 30 feet over several thousand years is likely too optimistic unless society finds ways to quickly reach zero emissions and lower the CO2 in the atmosphere," says the research paper published in Nature Climate Change.

"We now know how much more carbon we can emit to keep below a certain temperature. One way to begin looking at it from a policy standpoint is to ask the question, 'how much sea level rise can we tolerate?'" Clark said.

India has potential to be the global leader in tiger conservation: expert

She was only five months old when her mother died. On March 2016, she was taken almost 150 km from her home to the eastern part of Madhya Pradesh. Today, three-year-old tigress T-11 is thriving at Sanjay Dubri National Park in Madhya Pradesh.

Vincent Kabir, field director of the national park said that the tigress was radio-collared and released into the wild in October 2016 and in June 2017 she gave birth. In about a year, the three cubs will establish territories of their own.

Living free

"Over the past few years in Madhya Pradesh, we have released nine tigers after slowly acclimating them to the wild," said Rajneesh Kumar Singh, deputy forest conservator, Madhya Pradesh.

As the world celebrates Global Tiger Day on July 29, there are number of such success stories of tiger conservation that India can boast of. A few months ago, the first successful inter-state translocation of a pair of tigers was carried out from tiger reserves in Madhya Pradesh to Satkosia in Odisha.

The results of the ongoing All India Tiger Assessment, 2018, are expected by the end of the year. As per the assessment of the Status of Tigers, Co-predators and Prey (2014), the number of tigers in the country is estimated at 2,226 as compared to the 2010 estimate of 1,706.

"India being home to 70% of the tiger population in the world can be a global leader in tiger conservation," Rajesh Gopal, secretary general of Global Tiger Forum, told The Hindu. A lot more needs to be done on the conservation front, he said. "The tiger is a collective responsibility of all stakeholders and it cannot be left to the forest staff alone," Mr. Gopal said, highlighting the need for surveillance and maintenance of tiger corridors.

The Ministry of Environment recently said that 45% of the tiger deaths between 2012 and 2017 could be attributed to unnatural reasons. Of the 45%, 22% of the deaths were due to poaching, 15% due to seizures of body parts and the remaining could be attributed to road and railway accidents. Over the past few years, an instance of tigers travelling hundreds of kilometres looking for territory has come to the fore.

In 2017, 115 tigers died and in 2016, the number of deaths was 122.

The Ministry has admitted that there is a 29% frontline staff vacancy against sanctioned posts in the tiger reserves of the country. Mr. Gopal stressed on the need for capacity building of the forest staff.

Gaps in India's digital accessible information on bird occurrence

With citizen science, especially in bird sightings, taking off in the country, scientists tried to use these online data to study if bird occurrence has altered across India over time. Though a lot of information is available after the 2000s, they found very little data before 1980 has been made available digitally, making comparisons impossible.

Comparisons are crucial in science and tell us how natural systems change over time. The effects of climate change are also usually studied this way: comparisons of climate and bird occurrences in the past, for instance, can tell us how changing climates could have led to the avian patterns of the present.

It was with this in mind that scientists at the Wildlife Institute of India (WII) and the University of Kansas accessed more than 2 million bird occurrence data points from across India to evaluate the "digital accessible knowledge" of bird species occurrences. They explored two sources: the Global Biodiversity Information Facility (GBIF, a network funded by the world's governments focused on making scientific data on biodiversity available online); and eBird, the world's largest biodiversity-related citizen science project where users contribute information on bird sightings.

"Curating this data using multiple levels of filtering took a huge amount of time," said Gautam Talukdar (WII), co-author of a study published in Current Science.

Gaps in data

Finally, making sure each record had all necessary information including correct species names, they obtained 16,510 records of 1,021 species for the pre-1980 period, and 9,01,658 records of 1,151 species for post-2000,

clearly showing good coverage after 2000, but a paucity of data before 1980. Their maps reveal that the most spatially dense data after 2000 was from Kerala. Jammu and Kashmir, the higher elevations across the Himalayan front, and northeastern India had very sparse data.

Incorporating information from the several museum specimens – in foreign and Indian museums, as well as institutional collections (such as those in the Zoological Survey of India) – could be crucial to generate bird occurrence data before 1980, said Dr. Talukdar.

These gaps need to be addressed, agreed Praveen J. of Bird Count India (an Indian collective that coordinates several birding activities and encourages using eBird for documentation).

"Old papers may now be online but their data are not in searchable databases yet," Praveen said. "Even the field notebooks of some of India's birding pioneers are still in private shelves and not digitised."

IISER Pune find species can turn invasive in the same ecosystem

Invasive species are normally considered to come from outside a given ecosystem. But a study by researchers from the Indian Institute of Science Research and Education (IISER) Pune have shown that selection process for dispersal in fruit flies (Drosophila melanogaster) can lead to evolution of traits related to invasive potential. So a native species can become invasive in the same ecosystem.

Though the team led by Sutirth Dey from the Institute's Biology Division did not specifically study for invasion potential of the flies, the experiments they conducted did show the flies acquiring increased aggression, exploration and activity, which together is more likely to make them more invasive.

"Faced with vagaries of climate change and habitat destruction, there is an increasing possibility for the evolution of these traits in many mobile organisms," says Prof. Dey. If dispersal to safer environments is the "first line of defence" for organisms to cope with adversities, becoming an invasive species even within the same ecosystem might be the ugly fallout.

In a study published in June 2017 in Oikos, the researchers subjected four populations, each containing about 2,400 flies, to artificial selection for increased dispersal over 33 generations. This was done by placing the flies in a bottle and connecting it to another using a long pipe. Only the first 50% of flies that moved to the second bottle were allowed to breed. Thus there was a direct selection for dispersal propensity — ability to leave the source

area. And every 3-4 generations, the distance between bottles was increased by using a longer tube. This was done to mimic increased habitat fragmentation.

Dispersal traits

Within 10 generations of selection, the dispersal propensity and ability to travel long distances was significantly greater in the selected flies than the controls. The selected fruit flies displayed the similar characteristics after 20 generations.

"We checked for dispersal propensity in the 10th and 20th generation without food and water, which was similar to the selection procedure. The absence of food and water acted as drivers and led to increased dispersal propensity in the flies," says Sudipta Tung. "Then we became more ambitious and wanted to check whether the flies dispersed even in the absence of an external driver for dispersal. Even in the presence of food and water, we found that after 33 generations, the selected flies still displayed greater propensity and ability to disperse."

"Even when there was no reason for selected flies to disperse [due to presence of food], they were still dispersing. So dispersal had become constitute," he says.

The propensity to disperse was same in both sexes but males dispersed to longer distances than females. They also found that the selected population had larger number of flies that travelled long distances.

When organisms evolve in response to selection for greater dispersal the body size tends to become bigger. But in a paper published in Evolution , they found that selection did not lead to any increase in body size in both sexes. The studies were carried out using flies from 49-69 generations.

Selection for dispersal is likely to be at the expense of fecundity and longevity, but neither was observed.

Behavioural traits

"But we observed distinct changes in three behavioural traits — activity, exploration and aggression. And these three traits are closely related to the invasive potential of a species," says Tung.

The selected flies exhibited greater activity than the controls and this increased activity was seen in the absence and presence of food. After 24 hours, the activity of the selected flies was significantly more than the control males but the time spent resting and quality of rest/sleep were the same in the selected flies and controls.

The selected flies also exhibited greater exploratory tendency. This tendency helps the species to survive in a new environment. In many species, there is a strong relationship between exploration and invasion.

The selected flies exhibited greater aggression. even though there was no obvious fitness advantage. The selected flies did not have to compete with native flies either.

In collaboration with Dr. Kavita Dorai from the Department of Physical Sciences at IISER Mohali, the researchers looked at what was responsible for the change in behavioural traits. “Since dispersal is a complex process, it is difficult to figure out the genes responsible for it. So we looked at the changes in the levels of the underlying metabolites,” says Prof. Dey.

Octopamine, a neurotransmitter, was significantly elevated — 2.2 fold higher — in the selected flies. “The elevated octopamine level explains the underlying mechanism behind the observed changes in behavioural traits in the selected flies,” Prof. Dey says.

The selected flies showed increased levels of cellular respiration to meet increased energy demand. There was increase in the levels of Adenosine triphosphate (ATP), which is the energy currency for cells.

Meghalayan farms are also bird habitats

We know agricultural landscapes near protected areas are important habitats for wildlife in some regions. Now, researchers have proved this to be true in Meghalaya with the finding that wooded cultivated areas support multiple bird groups that play various roles — from insect controllers to fruit-eating seed dispersers — in the ecosystem. There are more than 100 bird species in the cultivated areas.

While several of India’s natural ecosystems including forests are now ‘Protected Areas’ (PAs), there are many patches that fall outside PA-limits but also support wildlife. Meghalaya's Nongkhyllem Wildlife Sanctuary and reserve forest are surrounded by community-managed forests and wooded betel leaf farms. A recent study by Wildlife Conservation Society-India found out how important these wooded areas are for birds.

The researchers studied how different groups (guilds) of birds — including nectar drinkers like sunbirds and insectivores such as drongos — use these two habitats and the different woodland vegetation found there. They find that areas outside the protected areas were used by all guilds of birds, suggesting that these areas maintained a functional bird community.

Studying the presence of such birds in these areas, the team examined the effects of vegetation structure — trees and shrubs — on the use of sites by different guilds of birds. They find that tree cover did not matter because most of these areas are highly wooded; shrub cover and bamboo influenced use of wooded areas by birds.

Species richness

The team also studied species richness in these areas. Surprisingly, agricultural woodlands supported more bird species than the protected areas did: bird species richness was higher in the wooded areas than in the protected areas due to increased number of generalist birds.

But that does not mean protected areas are not important; some specialised species are still dependent on them. “Birds including large woodpeckers were not spotted as much in farmlands,” said Syiem. “So wooded agricultural areas are important supplementary bird habitats.”

A lot of forests are at risk in Meghalaya because they are being converted into permanent open cultivation; encouraging regenerating forest areas or crops that require tree cover would be important, he added.

This well-designed study reinforces that at the landscape level, we can maximise the number of species we conserve by not just protecting natural habitats but also by ensuring the persistence of wooded areas (like regenerating forest) between protected areas, Princeton University-scientist Umesh Srinivasan says in an email.

Do hares benefit from wind farms?

With their tall turbines and rotating blades, wind farms often take the lives of bats and birds. But windmills could be life-savers for black-naped hares, suggests a preliminary study. Researchers find that these hares use a wind farm much more than forested areas in remote Karnataka.

Wind energy was long touted as ‘green’ until scientists began quantifying its various ecological costs, including the direct toll it takes on wildlife. Birds and bats often collide with the blades of wind turbines resulting in their death. Studies show that some groups of birds – such as birds of prey – avoid wind farms altogether.

While conducting research on the impact on birds and bats in a wind farm located in the Harada reserve forest (a scrub jungle in Karnataka's Davangere district) that the team from Coimbatore’s Salim Ali Centre for Ornithology and Natural History (SACON) noticed an odd thing: signs of black-naped hare (Lepus nigricollis) in the reserve forest where the turbines

were present were numerous, evident from the small, berry-like faecal pellets that they left behind on the wind farm while using the area. Could these little mammals be using the wind farm region more than the forest area where there were no wind turbines?

To find out, the team consisting of doctoral researcher V. Anoop and scientists P. R. Arun and Rajah Jayapal devised a simple field study to analyse the number of fresh hare pellets on the ground in the wind farm and forest as a sign of how intensely the animals used these areas. They counted pellets in 32 rectangular plots in each habitat type. Their results show that the hares did use the wind farms more than they did the forests without wind turbines. According to their simple density calculations, the wind farm had around three hares per hectare while the reserve forests supported at least one hare per hectare.

“But this is not a positive result,” said Mr. Anoop, author of the study published in the Journal of Threatened Taxa. “It suggests that hares are deviating from the norm and using a human-altered landscape more than their natural habitats”

Why could this be happening? The presence of the wind turbines could be eliminating aerial predators such as birds of prey. “Or, it could just be the fact that windmill installations set amongst natural vegetation structurally mimic the forest openings and edges, which are normally preferred by the hares,” said Mr. Anoop. “We hope to study this further. Though wind turbines have been installed in India since 1984, there are not enough studies on how they affect wildlife.”

Black bears and langurs strike a strange bond

Oaks and acorns have fostered an unlikely association between a predator and its prey. Primatologists notice that Himalayan black bears could be actively seeking out langurs during the oak fruiting season: not to hunt them, but to feed on the acorns that the primates accidentally let fall to the ground.

There are several instances – from India and other countries – where unrelated species benefit from feeding in the same area that others feed in. Herbivores such as deer often feed on forest fruits and remnants that fall when primates pluck out and eat fruits from trees above. It was while studying patterns of how central Himalayan langurs feed in Uttarakhand's Kedarnath Wildlife Sanctuary that researcher Himani Nautiyal (of Kyoto University's Primate Research Institute) suddenly noticed that in specific months, Himalayan black bears were frequenting the same area as the langurs. The bears, which are known to eat langurs when their usual food

resources are scarce, would position themselves under the fruiting oaks on which langurs were perched and feast on the acorns (oak fruits) that fell.

Behavioral patterns

Intrigued, Nautiyal and her colleague studied this in detail. Between June and September 2016, they spent 468 hours studying the behaviour of a troop of 26 langurs and looking for signs of bears nearby. Their results, published in theMammal Study, show that the percentage of individual langurs feeding on acorns was highest in the months of July and August — the same months that acorn season peaked. Nautiyal's three direct sightings of bears feeding on fallen acorns was also during these months.

"The bears were never far from the langurs during these months," said Nautiyal. "Sometimes they would even sleep under the trees that langurs slept on."

Bear scat

The team also frequently observed pale bear scat (caused by digested acorns) under these oaks; other indirect bear signs in the area included mangled shrubs (as bears searched for fallen fruits) and even bear sleeping dens dug out of tree hollows. So, could it be that bears are deliberately tracking langurs during this season to feed on fallen acorns?

"Yes, we think it could be an adaptive strategy by the bears," said Nautiyal. "It increases their foraging efficiency. They would not have to spend time climbing oaks to access these fruits, especially females with cubs."

However, longer-term studies would be crucial to understand this unique and never-before-reported feeding association between langurs and bears, she added.

Ocean mean temperature can better predict Indian summer monsoon

Sea surface temperature (SST) is routinely used for predicting whether the total amount of rainfall that India receives during the monsoon season will be less or more than the long-term mean of 887.5 mm. Now, scientists from Pune's Indian Institute of Tropical Meteorology (IITM) find that ocean mean temperature (OMT) that has better ability to predict this than the sea surface temperature. Compared with SST which has 60% success rate of predicting the Indian summer monsoon, OMT has 80% success rate.

In addition to better predictive success, the information on whether the amount of monsoon rainfall will be more or less than the long-term mean

will be available by beginning of April, two months before the southwest monsoon can set in. This is because OMT is analysed by measuring the ocean thermal energy during the period from January to March. Southwest monsoon sets in around June 1 each year in Kerala .

"Sea surface temperature gives information only about the thin upper layer of the ocean and does not reflect the thermal energy available in the upper ocean. The variations in the upper ocean thermal energy conditions are mainly responsible for summer monsoon activity," says M.M. Ali, senior scientist at IITM and corresponding author of a paper published in Scientific Reports.

"The heat content of the upper ocean creates more impact on monsoon than sea surface temperature, which is restricted to the skin of the ocean," says M. Rajeevan, Secretary, Ministry of Earth Sciences and one of the authors of the paper.

The SST is restricted to a few millimetres of the top ocean layer and is largely influenced by strong winds, evaporation, or thick clouds. In contrast, OMT, which is measured up to a depth of 26 degree C isotherm, is more stable and consistent, and the spatial spread is also less. The 26 degree C isotherm is seen at depths varying from 50–100 metres. During January–March, the mean 26 degree C isotherm depth in the Southwestern Indian Ocean is 59 metres.

The researchers analysed 25-year OMT data from 1993 to 2017. They found that unlike SST, OMT was able to correctly predict 20 out of 25 years (80% success rate) whether the amount of rainfall during the summer monsoon was more or less than the long-term mean. The prediction based on sea surface temperature was correct only for 15 out of 25 years (60% success rate).

"Using OMT data collected during January-March 2018, we were able to predict with 80% probability that this year's monsoon will be below average during June–September," says Dr. Ali.

Similarly, OMT showed better success in predicting above or below-average rainfall years compared with SST. For instance, OMT was able to successfully predict 13 out of 16 below average rainfall years and seven out of nine above average rainfall years during the period 1993-2017.

In contrast, the prediction based on SST was correct only in 10 out of 16 below average rainfall years and five out of nine above average rainfall years.

The reason why OMT performs better than SST is because OMT better represents the upper ocean thermal energy conditions. And the variations in

the upper ocean thermal energy conditions are mainly responsible for the summer monsoon. “When there is rapid heating or cooling, the temperature of the top ocean layer will be significantly different from the upper ocean thermal energy, resulting in misleading monsoon predictions,” says Dr. Ali.

In addition, SST also exhibits large temperature fluctuations compared with OMT of the upper layer, leading to more noise that causes lower correlations with summer monsoon rainfall. “The ocean means temperature variations are more stable and consistent and have lower spatial and temporal spread. So OMT has better summer monsoon predictability than SST,” says Dr. Ali.

Heavy metal contamination in south Indian banana fields

Decades after the pronounced use of chemical fertilizers and pesticides, its negative impacts are reaching new heights with heavy metal contamination now reported in banana fields of South India.

An extensive study of over 250 soil samples from three south Indian States — Kerala, Karnataka and Tamilnadu — has shown that most of the banana fields have amounts of copper, magnesium, chromium and cobalt higher than the threshold levels for normal soils.

Researchers from the Laboratory of Plant Science and Ecology at Mahatma Gandhi University, Kottayam, collected the different soil samples, categorised them according to soil taxonomy and used atomic absorption spectroscopy studies to analyse the level of different heavy metals.

Magnesium content

“We found an unusually high level of magnesium in the fields studied. While the magnesium content of soil in South Indian soil is known to be between 30 and 220 mg/Kg, the average of the samples tested was above 900 mg/Kg,” says Dr. K.S. Nidheesh, from St Joseph’s University, Dimapur in Nagaland, who is the first author of the work published in Environmental Science and Pollution Research. “This is a result of farmers using chemical fertilizers without proper soil testing and applying above the recommended level. As banana is highly prone to insect and nematode attack, they also more pesticides, which get accumulated in the soil.”

Calcium levels almost reaching the threshold were seen in many fields. Calcium is used to maintain the soil pH and over the years has accumulated in the soil. Another heavy metal recorded was manganese, which is a major component of pesticide used against fungal diseases like Fusarium wilt. Though the concentration of iron was high, the authors write it may be due to the laterite-based soil of the Deccan Plateau. Chromium, which rarely

occurs naturally in soil, was detected in all the samples studied, and many samples were at levels near the threshold.

First step

"This is a preliminary report and the beginning of an investigation. More studies are needed to fully understand if the plant is also accumulating the heavy metals. There has been evidence from across the world that banana fruit accumulates heavy metals. More studies in the Indian context and the effect of consuming these fruits also need thorough examination," adds Prof. Joseph George Ray from the School of Biosciences at the university and corresponding author of the work.

Scientists to study climate change impact on Kerala

CSIR-National Institute of Science Communication And Information Resources (NISCAIR), Delhi, under the ministry of science and technology, has proposed to the ministry of earth sciences a project to study the impact of climate change in Kerala, as the coastal state struggles to rebuild itself after the devastating floods in August.

The three-year project, which has an estimated budget of ₹79 crore, would involve more than 50 scientists from several research institutions including the Indian Institutes of Technology, laboratories of the Council of Scientific and Industrial Research, the National Institute of Oceanography, Cochin University of Science and Technology, and University of Calcutta, who would study climate change in the state and suggest adaptation measures.

"Effects of climate change are slowly becoming evident and the situation has been compounded after the recent floods in Kerala, which were the worst in the century," said Professor J. Sundaresan Pillai, head, climate change informatics, CSIR-NISCAIR and principal investigator of the project.

"Climate change cannot be prevented. We can only devise ways to adapt to it as early as possible. This is one such study to suggest such mitigation options for Kerala," said Pillai.

The scientists would analyse the impact of climate change on sectors such as agriculture, fisheries, industries, health, transport, tourism and forests.

The researchers would study variations in monsoons and their impact on the state, specifically extreme weather events, and also examine changes in water resources and dynamics of the rivers.

"Kerala has a unique climate. It witnesses roughly six months of rain in a year and some rare phenomenon, such as the mud banks that appear every

year during the southwest monsoon," said Pillai, who led the VACCIN project for developing climate mitigation plan for coastal systems and islands in Lakshadweep in 2015.

The project would also involve using Continuous Plankton Recorders (CPRs) in the Arabian Sea to understand the migration of fishes because of the rise in seawater temperatures, which can also affect the livelihood of people in years to come. This is more so as recent research has shown that climate change is forcing fishes to migrate faster in search of colder waters.

The scientists would create specific measures for Kerala, taking into consideration the likely effects of climate change on existing road infrastructure and ways to adapt road construction along with identifying landslide-prone hills along state highways.

Vulnerability assessment of coastal areas would be done with the help from scientists from CSIR-National Institute of Oceanography, Goa, who would also demarcate vulnerable regions in wake of rise in sea-water levels.

"It would be a long-term study. The project heavily relies on cooperation from local people and local bodies in adopting appropriate measures in development activities," said Pillai, who is also the principal investigator of the project.

Researchers dive in to restore coral ecosystems

Coral reefs are among the most diverse ecosystems on earth, and their role in maintaining marine biodiversity is of no small measure. However, it is well documented that coral systems around the world are bleaching and dying due to climate and chemical changes in the sea water. A team from National Centre for Coastal Research, Chennai, plans to work on coral monitoring and restoration in the Gulf of Mannar region. "We assess the location and coverage of corals through remote sensing, then study how the sediment affects the coral reef," says T Shunmugaraj, who leads this project along with M V Ramanamurthy, Director, NCCR. The team will also set up an acquatech park which will help local persons rear marine ornamental fish towards a sustainable livelihood.

The group has prior experience in studying corals across the country. They have successfully transplanted and nurtured corals in the Lakshadweep region. Now they are set to work in the Gulf of Mannar.

Coral bleaching

Corals have a symbiotic relationship with the unicellular algae dinoflagellates. An increase in sea surface temperatures leads to coral bleaching and the breaking of this relationship.

Not all corals are equally sensitive. The most susceptible are the branching corals, for example, Acropora species, and the least susceptible are the massive ones, for example Favia species.

Coral reefs in India are only seen in some localities around the Gulf of Mannar, Gulf of Kutch, Lakshadweep islands and Andaman and Nicobar Islands. In many of these places, bleaching of corals and related cnideria species such as giant clam and tentacle sea anemone have been observed by the team.

However, constructive interventions exist for this problem. The methods include reducing harvest of herbivorous fish and minimising anthropogenic causes of bleaching.

The National Centre for Coastal Research, which comes under the Ministry of Earth Sciences, conducted a mapping of corals for Gulf of Kutch, Gulf of Mannar, Lakshadweep and Andaman and Nicobar islands over a period of five years, from 2000 to 2005. Their results were startling, as they found less than 40% of the coral reefs in India were still alive.

From 2005 to present, the team, with support from Department of Science and Technology, has surveyed the area around Agatti and Kavaratti islands in the Lakshadweep, and in an area approximately one acre, transplanted branching corals, massive corals and foliac corals. “We take a small polyp, tie it to an iron frame and take it underwater. The iron frame is needed because if you place it directly, sediments will fall on them,” explains Dr. Shunmugaraj.

Restoration efforts

Over the last decade, this region has seen restoration of live corals in these areas. The team found that the branching coral Acropora could grow 25 cm in 3 years. Another genus, Pocillopora, grew 15 cm in 3 years.

The researchers plan to replicate the model in the Gulf of Mannar region, and towards this end, they have set up a centre in a 25-acre piece of land near the Rameshwaram coast. Partnering with Gulf of Mannar Marine National Park Authority, they will first monitor the 21 islands in this region and identify degraded areas.

In January, after the monsoons, they plan to start transplantation work with branching coral species.

Lizards adapt to city life

Moving to a city means adapting to different surroundings. And it's no different for lizards in Bengaluru city too, find scientists: Indian rock agamas here are changing their physiology — including lowering their testosterone levels — to adapt to urban life.

Some wild animals (including rock agamas which are usually found in the south Indian countryside) are at home in urban areas too. Some species are 'exploiters': using urban areas greatly to their advantage, they thrive better here. Others are 'adapters': making a few changes, they use the new areas, but only nearly as well as they do in their natural habitats. Identifying species as adaptors or exploiters helps assess the health of animals in disturbed areas and develop better management plans for them.

The standard way to find out if Bengaluru's agamas are adapters that can cope with urban life would be to observe their behaviour (many lizards change their behaviour in urban areas). However, Madhura Amdekar and her colleagues at Bengaluru's Indian Institute of Science took a different approach: they studied agama physiology, for urbanisation does affect physiology and compromised physiological conditions would mean that the lizards are trying to adapt. They identified 41 urban lizards in Bengaluru city and 42 others in the rural Anthargange forest range, 60 km away. The team captured these lizards and measured their body conditions, parasite levels on the skin and cell-mediated immunity (a kind of immune response to foreign and potentially harmful substances) in the laboratory. They also studied hormone levels and heterophil-to-lymphocyte (H:L) ratios in the blood, which are indicators of stress and immunity levels.

According to senior author Dr. Maria Thaker, "This approach of measuring several indicators simultaneously gives us a better understanding of how the body prioritises its response to challenges."

Their results published in Frontiers in Ecology and Evolution show that urban lizards had lower testosterone levels and H:L ratios. This is a sign that they are coping with their urban surroundings, said lead author Amdekar.

"Testosterone, for instance, mediates fighting and aggression," she said. "One small patch may hold many lizards in urban areas, so competition between them would be high. Lower testosterone levels would be crucial to adapt to such competition."

This is the first study to show that physiological measures can reveal whether a lizard species in an adapter or exploiter. However, it is crucial to use multiple measures of physiology to test this, added Amdekar.

DNA metabarcoding reveals herb-specific diet of pikas

Animal poop may seem inconsequential but it supplies scientists with precious information: from a tiger's identity to elephant stress levels. Most recently, faeces of Royle's pika – a small rabbit-like mammal found in India's Himalaya – reveal that these animals survive almost entirely on specific plants that grow only in cold, wet conditions; plants that are not expected to tolerate the warmer weather that climate change would bring.

Warmer weather can alter plant communities in high-altitude ecosystems like the Himalaya and also affect animals that depend on them. For instance, fossil records reveal that cold-loving pikas dwelt in parts of then-frigid Africa, too. However, warmer weather around 5-10 million years ago reduced the 'C3' plants (ancient plants that use more water during photosynthesis and can survive only in cold and wet climes) that the pikas ate, leading to the animals' extinction.

In such times, unravelling animal diets is crucial, and researchers at Bengaluru's Indian Insitute of Science and the University of Sheffield deciphered the plant families that the Royle's pika – which prefers rocky areas, especially tali (piles of rock that accumulate at mountain bases) – eats. They collected 172 pika faeces (pellets) from five locations in Uttarakhand including the Nandadevi Biosphere Reserve. In the laboratory, they used a method known as DNA 'metabarcoding', which helps identify the DNA of plant species in animal faeces.

Pellet facts

The researchers found that the pellets contained 79 different genera of plants (earlier, visual observations of animals feeding had revealed only 26 species); 97% of these are C3 plants that cannot tolerate hot and dry weather. The results, published in Molecular Ecology, also reveal that the pikas prefer forbs (flowering herbs) over grasses; more than 50% of plants they eat are endemic to the Himalayas. Interestingly, the team also find that characteristics of a talus can influence plant diversity; a larger talus increased plant species, offering pikas a more diverse diet. "A talus with deeper and wider crevices permits easy access for predators," said Bhattacharyya. "We found that pikas dwelling in such areas had a lower diversity of plants in their diets since predation risks made them more cautious."

Currently, there is no dearth of C3 plants available for the pikas that are distributed widely between 2,400-5,000 metres in the Himalaya. However, pikas could be affected if climate change reduces the distribution of C3 plants that the mammals feed almost entirely on, write the authors.

River pollution: NGT directs States to act

Taking suo motu cognisance of a report in The Hindu on the increase in polluted river stretches in the country, the National Green Tribunal (NGT) has directed all States and Union Territories to prepare action plans within two months.

Stating that the action plans should aim at improving the polluted stretches for "at least bathing purposes", a bench headed by NGT Chairperson Justice Adarsh Kumar Goel said, "We are of the view that the situation is far from satisfactory and action is required to be taken on war footing. There has to be meaningful further action to restore the minimum prescribed standards for all the rivers of the country."

The Hindu, on September 17, had reported, quoting data from the Central Pollution Control Board that the number of polluted rivers stretches in the country had increased to 351 from 302 over the last two years.

The tribunal specified that Chief Secretaries of each State and administrators of UTs will be "personally accountable for failure to formulate action plan."

The bench directed that four-member committees, comprising representatives of State pollution control boards and the State governments, be constituted for preparing and executing the action plans.

"The action plan will include components like identification of polluting sources including functioning or status of sewage treatment plants, common effluent treatment plants, solid waste management and processing facilities, quantification and characterisation of sewage generated in the catchment area of the polluted river stretch" the bench said.

Stating that the pollution control boards had failed to check pollution, the bench said, "They have not been able to stop dumping of waste, discharge of effluents in rivers and water bodies."

Bengal officials race against time to save rescued corals

Unlike the other seizures in the past, officials of the Wildlife Crime Control Bureau (WCCB) faced a different kind of challenge when they recovered 20 live corals from a house in Dum Dum in north Kolkata. While there are

routine reports of smuggling of birds, turtles, elephant tusks and rhino horns, instances of coral smuggling are rare.

On interrogation, the 26-year-old accused, Upendranath Goswami, said he had received the corals from the Thoothukudi coast in Tamil Nadu, part of the Gulf of Mannar landscape. Goswami was allegedly trying to sell them to marine hobbyists.

Located along the eastern coast between the island of Rameswaram and Thoothukudi, a cluster of islands in the Gulf of Mannar is home to an expansive reef population.

"If the corals need to be saved they should be restored in their natural reefs in Tuticorin. We have contacted the officials of Tamil Nadu Forest department and sought permission of the Court in West Bengal so that these corals can be restored to their natural habitat," Deputy Director, WCCB, Eastern Region, Agni Mitra told The Hindu .

Court nod for return

A court in Barrackpore granted permission for the live corals to be transported back to Tamil Nadu.

The seizure was carried out jointly by the WCCB and Forest Directorate, West Bengal, late evening.

All the hard corals seized are protected marine wildlife listed in Schedule-I of The Wildlife Protection Act, 1972 and any attempt of smuggling and commercially exploiting these resources involves a minimum term of three to seven years, Mr. Mitra added.

WCCB officials said live corals are very sensitive to water parameters and they have temporarily engaged the accused under a custody bond (zimmanama) for maintenance of the corals.

After obtaining necessary clearances from the court, the live corals will have to be restored to the natural habitat within 24 to 48 hours.

While in other cases of wildlife smuggling, the live animals or birds are released into nearby forests and suitable habitats, in this case the corals will be flown about 2,000 km to be restored to their natural habitation.

Better enforcement

Saket Badola, head of TRAFFIC India, a leading NGO working globally on trade in wild animals, said there were reports of corals being traded and more action should be taken by enforcement agencies to tackle the illegal

trade. “Corals are facing threat of climate change and smuggling can be an added threat,” Mr. Badola said.

Describing the smuggling of corals as a very serious issue, coral expert and scientist at the Zoological Survey of India (ZSI), Tamal Mondal, welcomed the effort on the part of the WCCB to restore the corals to their natural habitation. He identified the seized live corals under genus Goniopora sp, Favites sp and Symphyllia sp.

“It is not easy to extract a live coral from its reefs by bare hands; tools like hammers and chisel must have been used. This also indicates a smuggling network which needs to be busted to save the coral ecosystem,” Mr. Mondal said.

Corals are considered to be among the most dynamic ecosystems, providing shelter, and physical and ecological support to marine flora and fauna.

The scientist said there are only four coral major reef areas in the Indian waters in the Andaman & Nicobar Islands, the Gulf of Mannar, Lakshadweep and the Gulf of Kutch, where all of three major types of reefs — fringing, atoll & barrier — are found.

59 plant species in IUCN threat categories

Threatened wildlife is not just about tigers but numerous plants too. Recently, scientists identified the threat status of 59 Indian plant species based on criteria used by the International Union for Conservation of Nature (IUCN), in the hope that this “streamlines” conservation efforts for the plants.

Quantifying threat levels of species can be crucial for their conservation. For instance, funding agencies often consider the threat status of species provided in IUCN's Red List (a catalogue of the world's threatened species), to sponsor research and conservation activities to save them. Around 2,700 plant species in India are at risk but very few have been assessed by the IUCN, according to Dr. S.K. Barik, Director of Lucknow's CSIR-National Botanical Research Institute.

To bridge this gap, Dr. Barik and experts from several institutes prioritized 59 plant species that are at risk of “elimination” if the threat levels they face are not assessed soon. They assigned each species a threat status based on IUCN criteria.

This included the extent and area of each plant's geographical range, which revealed that 10 species are critically endangered, 18 endangered, six

vulnerable, five near threatened and one species each are data deficient and least concern.

The threat levels of some plants have been altered as a result; for instance, the palm Bentinckia nicobarica is currently listed as endangered; however the new study suggests it is critically endangered based on its distributional attributes (the palm is reported only from the Great Nicobar Island).

Based on population sizes and numbers of mature individuals remaining in the wild (using field surveys that also revealed that habitat loss was a huge factor affecting many declining plant populations), the team classified 10 species as critically endangered, three as endangered and five as vulnerable. Germination tests in the laboratory also suggest that factors such as low seed viability could have caused declines in the wild too.

The study initiated in 2012 to assign threat status to select plants, is published in Current Science. The study also generated data on 38 species that have never been assessed by the IUCN.

"We hope IUCN will take this assessment into account while updating their Red List," said lead author Dr. Barik.

"Yes, IUCN will take into consideration this published information when these species do come up for assessment," confirmed Dr. N.M. Ishwar, programme coordinator of IUCN-India, by email.

Arctic observations to predict tropical cyclones

Weather observations in the Arctic can help track tropical and mid-latitude cyclones more accurately, improving the forecast of extreme climate events, scientists say.

"Extreme weather events have been frequently observed in all seasons all over the world," said Kazutoshi Sato, an assistant professor at the Kitami Institute of Technology in the US. "Hurricanes and typhoons are one of the most influential phenomena for human life. Precise weather forecast is critical to enable communities to adequately prepare for weather disasters."

For the study published in the journal Scientific Reports, researchers performed weather forecast experiments for three tropical cyclones that occurred over the North Atlantic and North Pacific during 2016, to determine whether additional observations could help predict their paths and intensity more accurately. To supplement existing weather data observations, additional observations were conducted using weather balloons released from ship- and land-based weather stations based in the Arctic.

The data were analysed using a data assimilation system developed in Japan Agency for Marine-Earth Science and Technology, which can produce reanalysis datasets by "mixing" observations into global atmospheric conditions. The observations improved the predictability of the cyclones, allowing the scientists to track the paths of the cyclones as well as forecast their intensity more accurately.

"This study demonstrated the usefulness of additional Arctic observations for mid-latitude numerical weather forecasts for tropical cyclones," said Jun Inoue, from NIPR.

Adamant Algae

Global warming may be affecting almost all species on Earth, but not the green algae Picochlorum. A new study published in Molecular Biology and Evolution has said that having survived in hostile and fluctuating conditions in the salt marshes and salt flats, these algae have a set of genes that may help it survive climate change.

Phosphorus from space

A study published in Nature Communications has pointed out that most of the phosphorus on Earth was generated in outer space and reached Earth via meteorites and comets. The paper says that meteoritic phosphides interacted with the biomolecules under terrestrial conditions and led to the formation of early key phosphorus acids.

IISER Pune find species can turn invasive in the same ecosystem

Invasive species are normally considered to come from outside a given ecosystem. But a study by researchers from the Indian Institute of Science Research and Education (IISER) Pune have shown that selection process for dispersal in fruit flies (Drosophila melanogaster) can lead to evolution of traits related to invasive potential. So, a native species can become invasive in the same ecosystem.

Though the team led by Sutirth Dey from the Institute's Biology Division did not specifically study for invasion potential of the flies, the experiments they conducted did show the flies acquiring increased aggression, exploration and activity, which together is more likely to make them more invasive.

"Faced with vagaries of climate change and habitat destruction, there is an increasing possibility for the evolution of these traits in many mobile organisms," says Prof. Dey. If dispersal to safer environments is the "first

line of defence" for organisms to cope with adversities, becoming an invasive species even within the same ecosystem might be the ugly fallout.

In a study published in June 2017 in Oikos, the researchers subjected four populations, each containing about 2,400 flies, to artificial selection for increased dispersal over 33 generations. This was done by placing the flies in a bottle and connecting it to another using a long pipe. Only the first 50% of flies that moved to the second bottle were allowed to breed. Thus there was a direct selection for dispersal propensity — ability to leave the source area. And every 3-4 generations, the distance between bottles was increased by using a longer tube. This was done to mimic increased habitat fragmentation.

Dispersal traits

Within 10 generations of selection, the dispersal propensity and ability to travel long distances was significantly greater in the selected flies than the controls. The selected fruit flies displayed the similar characteristics after 20 generations.

"We checked for dispersal propensity in the 10th and 20th generation without food and water, which was similar to the selection procedure. The absence of food and water acted as drivers and led to increased dispersal propensity in the flies," says Sudipta Tung. "Then we became more ambitious and wanted to check whether the flies dispersed even in the absence of an external driver for dispersal. Even in the presence of food and water, we found that after 33 generations, the selected flies still displayed greater propensity and ability to disperse."

"Even when there was no reason for selected flies to disperse [due to presence of food], they were still dispersing. So dispersal had become constitute," he says.

The propensity to disperse was same in both sexes but males dispersed to longer distances than females. They also found that the selected population had larger number of flies that travelled long distances.

When organisms evolve in response to selection for greater dispersal the body size tends to become bigger. But in a paper published in Evolution , they found that selection did not lead to any increase in body size in both sexes. The studies were carried out using flies from 49-69 generations.

Selection for dispersal is likely to be at the expense of fecundity and longevity, but neither was observed.

Behavioural traits

"But we observed distinct changes in three behavioural traits — activity, exploration and aggression. And these three traits are closely related to the invasive potential of a species," says Tung.

The selected flies exhibited greater activity than the controls and this increased activity was seen in the absence and presence of food. After 24 hours, the activity of the selected flies was significantly more than the control males but the time spent resting and quality of rest/sleep were the same in the selected flies and controls.

The selected flies also exhibited greater exploratory tendency. This tendency helps the species to survive in a new environment. In many species, there is a strong relationship between exploration and invasion.

The selected flies exhibited greater aggression. even though there was no obvious fitness advantage. The selected flies did not have to compete with native flies either.

In collaboration with Dr. Kavita Dorai from the Department of Physical Sciences at IISER Mohali, the researchers looked at what was responsible for the change in behavioural traits. "Since dispersal is a complex process, it is difficult to figure out the genes responsible for it. So we looked at the changes in the levels of the underlying metabolites," says Prof. Dey.

Octopamine, a neurotransmitter, was significantly elevated — 2.2 fold higher — in the selected flies. "The elevated octopamine level explains the underlying mechanism behind the observed changes in behavioural traits in the selected flies," Prof. Dey says.

The selected flies showed increased levels of cellular respiration to meet increased energy demand. There was increase in the levels of Adenosine triphosphate (ATP), which is the energy currency for cells.

NGT junks plea to retain wall on elephant corridor

The National Green Tribunal has dismissed a review petition by a refinery in Assam for retaining a concrete boundary wall with barbed wire on a part of a reserve forest, stating that elephant corridors need to be protected.

Dismissing a review petition filed by Numaligarh Refinery Limited, a Bench headed by NGT chairperson Adarsh Kumar Goel said, "The counsel for the review petitioner submits that the entire wall need not be demolished as the same is not a part of the Deopahar Reserve Forest. We are of the view that in view of categorical finding already recorded by the tribunal, that the area where the wall came up and the area where proposed township is to come

up is a part of the Deopahar Reserve Forest, rehearing on merits is not permissible."

The NGT gave its order after hearing a plea filed by Assam-based green activist Rohit Choudhury, who had sought directions to demolish the 2.2 km wall constructed by the refinery near the reserve as it was obstructing the movement of elephants.

Based on an earlier petition by Mr. Choudhury, the NGT had in August 2016 asked NRL to demolish the wall around an extended part of its township acquired for residential complexes.

The green panel had also imposed an environmental compensation of Rs. 25 lakhs on the refinery for constructing a boundary wall for a golf course, that had led to the flattening of a hill measuring 5 hectares and destruction of forest.

Close to National Park

The refinery, close to Kaziranga National Park and about 260 km east of Guwahati, was expected to demolish the wall within a month. It wasn't until March this year the Golaghat district administration and forest department demolished about 220 metres of the wall.

But the refinery filed the review petition saying that the tribunal had not considered the clearance of the State Environment Impact Assessment Authority for the project.

Noting the death of 12 elephants due to the "barbed-wire and razor's edge fencing" atop the boundary wall, the tribunal said it was clear that the NRL constructed the barrier in 2011 in the way of an elephant corridor and encroaching upon Deopahar as well as a no-development zone the Ministry of Environment and Forest had notified around Kaziranga National Park in 1996.

Apart from the high-rise wall, the NGT noted that the refinery had flattened a tree-rich hill covering about 5 hectares to make a golf course without approval of the Centre or compensatory afforestation, "thereby leading to environmental degradation".

The NRL had in 1996 acquired 750 bighas (107.14 hectares) of land for its old township and secured it with a boundary wall. It acquired another 67 bighas (9.57 ha) of tea estate land in 2008 for expansion of the township.

Khangchendzonga Biosphere Reserve enters UNESCO list

The Khangchendzonga Biosphere Reserve (KBR) of Sikkim, the highest biosphere reserve in the country that includes the third highest mountain peak in the world, Kanchenjunga (8,586 m), has been included in the UNESCO's World Network of Biosphere Reserves (WHBR).

The decision was taken at the International Coordinating Council of Man and Biosphere Reserve Programme, UNESCO, in its 30th Session held at Palembang, Indonesia, last month, a press release by Ministry of Environment and Forest and Climate Change said.

With the inclusion of the KBR, one of the highest ecosystems in the world, reaching elevations of 1,220 m to 8,586 m above sea level, the number of biosphere reserves from the country included in World Network of Biosphere Reserves has increased to 11.

The last biosphere reserve to be included was the Agasthyamalai Biosphere Reserve in Kerala in 2016. The Nilgiri Biosphere Reserve was the first reserve from the country to be included in the WNBR. India has 18 biospheres reserves, of which 11 have been included in the WNBR.

Boost to research

C.S. Rao, Additional Principal Chief Conservator of Forest, Sikkim, said the inclusion of the KBR in the UNESCO list will boost the unique ecosystem of Sikkim on two counts: collaborative research and tourism.

"This development will boost international research collaboration relating to flora, fauna and ecosystem of the KBR. Sikkim, with a population of about 6 lakh, gets15 lakh tourists annually. This will help us get more tourists," Mr. Rao said.

Explaining, the importance of the KBR for Sikkim, he said the biosphere reserve comprises 41% of the entire geographical area of the mountain State. "Of the 2,931 sq km area of the KBR, 1,784 sq km is the core area of the biosphere sphere, 835 sq km buffer area and 311 sq km comprises transition area between habitation and the biosphere reserve," Mr. Rao said.

The Khangchendzonga National Park (KNP), which comprises the core area of the KBR, was inscribed as India's first "Mixed World Heritage Site" on July 17, 2016. Eighty six per cent of the core lies in the Alpine zone and the remaining portions are located in the Himalayan wet temperate and sub-tropical moist deciduous forest.

Biodiversity hotspot

The Khangchendzonga Biosphere Reserve is one of the world's 34 biodiversity hotspots that has good species diversity with high levels of endemism, with many mountains, peaks, lakes, caves, rocks, stupas (shrines) and hot springs.

According to the Sikkim Forest Department, there are 4,500 species of flowering plants in the KBR, including 424 medicinal plants and 36 rhododendrons, 60 species of primulas and 11 varieties of oaks .

The biosphere reserve has also listed 362 species of ferns."Over 118 species of the large number of medicinal plants are found in Dzongu Valley in north Sikkim," a press statement of the PIB said.

Mr. Rao said that many species protected under the Wildlife Protection Act have their home in the KBR. This includes the Red Panda, Snow Leopard, Himalayan Black Beer and herbivores species of Musk deer, Great Tibetan Sheep, Blue Sheep, Boral and Barking Deer. Over 500 species and sub-species of birds, including high-altitude pheasants — Monal Pheasants, Tragopan Pheasants and Blood Pheasants (the State Bird) — are also found in the reserve.

Mumbai gives India its first baby penguin

The kind of tension typically felt outside a maternity ward was seen at Byculla zoo. Anxious minutes passed as staffers waited for the baby's arrival. And at 8.02 p.m., they saw, via CCTV, the sight they had anticipated for 40 days — the first Humboldt penguin to be born in India, or as someone put it, 'the freedom baby', born on August 15.

The seven penguins in Byculla zoo paired up soon after being placed in their enclosure more than two years ago, with only little Bubbles remaining single. Donald and Daisy, Olive and Popeye, and Mr. Molt and Flipper achieved celeb status. In fact, three-year-old Mr. Molt, the new father, had a brief fling with Bubbles before dumping her for Flipper, who is four-and-a-half years old.

The couple built a home using the bamboo, sand, and pebbles kept for the purpose. On July 5, Flipper laid an egg, the first one of the colony. Since then, the parents had been taking turns to incubate it.

Alert parents

"If the egg is infertile, the parents find out soon enough, and abandon it. But they did not do so, and that was the first sign of hope," said Dr. Sanjay Tripathi, director of Byculla zoo.

The egg's 40-day incubation ended on August 15. The same day, after 7 p.m., zoo authorities saw cracks on the egg. The chick used its beak to eventually break it open at 8.02 p.m. "It made a shrieking sound while coming out. The chick remained with the parents. It was only in the morning that we went to inspect it," said Dr. Madhumita Kale, head veterinarian.

It weighed 75 gm and was reported to be healthy. The average weight of a healthy newborn penguin is 60-80 gm. The zoo will conduct a DNA test to determine its sex, the baby ate the same seafood as the parents, who regurgitate and feed it the slurry. The chick's eyes have not fully opened, and it was in a prone position. It would be up on its feet only after a week. It can swim only after a few months from now.

In rhino country, a division to boost conservation efficiency

In about a week's time, an entire forest division in Assam will start moving 160 km northeast. The one-horned rhino of the Kaziranga National Park (KNP) is the reason for this "long march".

On August 14, Assam's Environment and Forest Department issued a notification saying the KNP had been split into two divisions — the existing Eastern Assam Wildlife and the new Biswanath Wildlife — for "intensive wildlife management".

The Brahmaputra separates the two divisions straddling a total area of 1,030 sq.km. Kaziranga had an area of only 232 sq.m when it began its journey as a proposed reserve forest on June 1, 1905.

The KNP officials said the creation of the Biswanath Wildlife Division, with headquarters at Biswanath Chariali in northeastern Assam, will entail relocating the Central Assam Afforestation Division at Hojai 160 km away. In fact, the afforestation division has been renamed a wildlife division.

All these years, the KNP was being administered by the Eastern Assam Wildlife Division with headquarters at Bokakhat on the southern bank of the Brahmaputra. This division was formed in 1966, two years before the State government designated Kaziranga a national park, though it was given the official status in 1974.

The Eastern Assam Wildlife Division had five ranges — Eastern or Agratoli, Kaziranga or Kohora, Western or Bagori, Burapahar and Northern — until the split. All except the Northern Range are on the southern bank of the Brahmaputra. Now, the Northern Range, with an area of 401 sq.km, has been upgraded to the Biswanath Wildlife Division with four ranges of its own — Eastern or Gamiri, Central or Biswanath Ghat, Western or Nagshankar and Crime Investigation Range.

"Much of the rhino poaching was being done from the northern side of the Brahmaputra, which was difficult to manage for officers posted on the southern side. Splitting the KNP into two divisions means there will now be two divisional forest officers under one director (based in Bokakhat near the Agratoli range), ensuring better vigil," Assam's Principal Chief Conservator of Forest N.K. Vasu told The Hindu.

"We will start moving to Biswanath in six or seven days. Not all the officers and staff of the division to be shifted might be suited for wildlife protection, so there could be transfers. But at the end, Kaziranga will now have many more hands," he said. He could not provide an estimate of the number of people to be shifted to Kaziranga.

The KNP, a UNESCO World Heritage Site since 1985, currently has a staff strength of nearly 1,300. Wildlife officials estimate that the park would require at least 3,000 men if they were to be deployed in eight-hour shifts.

Between 2015 and February this year, 74 rhinos fell to poachers in Assam. Many of these rhinos were from the KNP, though there have been fewer cases of poaching since 2017.

According to the last rhino census in March, the KNP has an estimated 2,413 rhinos. The park also has 57% of the world's wild water buffalo population, one of the largest groups of Asian elephants and 21 Royal Bengal tigers per 100 sq.km – arguably the highest striped cat density.

Meghalayan farms are also bird habitats

We know agricultural landscapes near protected areas are important habitats for wildlife in some regions. Now, researchers have proved this to be true in Meghalaya with the finding that wooded cultivated areas support multiple bird groups that play various roles — from insect controllers to fruit-eating seed dispersers — in the ecosystem. There are more than 100 bird species in the cultivated areas.

While several of India's natural ecosystems including forests are now 'Protected Areas' (PAs), there are many patches that fall outside PA-limits but also support wildlife. Meghalaya's Nongkhyllem Wildlife Sanctuary and

reserve forest are surrounded by community-managed forests and wooded betel leaf farms. A recent study by Wildlife Conservation Society-India found out how important these wooded areas are for birds.

The researchers studied how different groups (guilds) of birds — including nectar drinkers like sunbirds and insectivores such as drongos — use these two habitats and the different woodland vegetation found there. They find that areas outside the protected areas were used by all guilds of birds, suggesting that these areas maintained a functional bird community.

Studying the presence of such birds in these areas, the team examined the effects of vegetation structure — trees and shrubs — on the use of sites by different guilds of birds. They find that tree cover did not matter because most of these areas are highly wooded; shrub cover and bamboo influenced use of wooded areas by birds.

Species richness

The team also studied species richness in these areas. Surprisingly, agricultural woodlands supported more bird species than the protected areas did: bird species richness was higher in the wooded areas than in the protected areas due to increased number of generalist birds.

But that does not mean protected areas are not important; some specialised species are still dependent on them. “Birds including large woodpeckers were not spotted as much in farmlands,” said Syiem. “So wooded agricultural areas are important supplementary bird habitats.”

A lot of forests are at risk in Meghalaya because they are being converted into permanent open cultivation; encouraging regenerating forest areas or crops that require tree cover would be important, he added.

This well-designed study reinforces that at the landscape level, we can maximise the number of species we conserve by not just protecting natural habitats but also by ensuring the persistence of wooded areas (like regenerating forest) between protected areas, Princeton University-scientist Umesh Srinivasan says in an email.

Rise in extreme weather events in India raises concerns over climate change impact

As heavy rains pound Kerala and overflowing rivers inundate most of the state, the increasing numbers of instances of extreme weather events in India have deepened concerns about the impact of climate change.

"Heavy rainfall used to occur in Kerala, but not with such continuity. This time, there has been widespread rain continually for a long time which has not been seen in recent years. However, we have observed that the intensity of daily rainfall is indeed increasing, especially along the western coast and in the north-eastern states," said Dr D.S. Pai, head, climate prediction group, India Meteorological Department (IMD), Pune.

One such analysis done by IMD researchers has indicated increased disaster potential for instant flooding over central India, where the intensity and frequency of heavy and very heavy rainfall have been increasing.

"Our vulnerability to extreme rainfall is increasing as more people are living in low-lying areas and land development is changing drainage patterns. When there is more rain than the soil can absorb, water will quickly run-off overwhelming streams, drains and rivers, and causing flash floods," said Dr Roxy Matthew Koll from Indian Institute of Tropical Meteorology, Pune, whose recent study in Nature highlighted that the number of extreme rainfall events have gone up by threefold in India.

According to the study, there have been 285 reported flooding events in India over 1950-2017 affecting about 850 million people, leaving 19 million homeless and killing about 71,000 people.

In its recent State of the Climate Report, the US-based National Oceanic and Atmospheric Administration (NOAA) also raised concerns about the number of casualties in India because of extreme rainfall events last year. As many as 800 lives were lost in heavy rain and flood related incidents during the monsoon last year, it noted.

"It was expected that extreme weather events would increase because of climate change, and it is happening across the globe. India is more vulnerable because of its wide geographical and demographic variations. This makes it all the more important to strengthen our climate mitigation plans," said Malti Goel, former advisor, department of science and technology and founder, Climate Change Research Institute, Delhi.

More than 40 million hectares or 12% of the country's land is prone to floods and river erosion, according to the National Disaster Management

Authority (NDMA), which says disasters seriously threaten India's economy, its population and sustainable development, mainly because of its increasing vulnerabilities related to changing demographics and socio-economic conditions and unplanned urbanization.

Severe weather events have caused catastrophic loss of life and property across the country in recent years. Torrential rainfall caused floods in Jhelum and Chenab in 2014, causing nearly 400 villages in Kashmir to submerge. Chennai bore the brunt next year in November 2015, Assam in 2016. In 2017, Mumbai and Gujarat were forced to shut down because of record heavy rainfall.

Uttarakhand is yet to recover from the trail of destruction left by flash floods in June 2013, which was the country's worst natural disaster since the tsunami of 2004.

An 'ops room' to manage flood relief

The Disaster Management State Control Room set up in the Secretariat here has virtually become an emergency operation centre, responding immediately to distress calls from the flood-hit and for effective implementation of rescue-and-relief operations.

Housed in room 372 of the Main Block of the Secretariat that has the office of Additional Chief Secretary, Revenue and Disaster Management, the 24x7 control room swung into action from August 8 to ensure proper coordination among various stakeholders engaged in rescue-and-relief operations and in transportation.

Though rescue operations in flood-affected areas are almost over, the control room was still a beehive of activity for the post-flood relief operations with officials of various agencies busy with the task of ensuring that the relief materials reached the camps and the needy.

"Each relief operation is being monitored closely from the point of origin to the 3,594 relief camps set up in the State. Border-to-border pilot is also being provided to ensure that the relief materials reach the needy," an official who is attached to the control room since it started functioning said.

Weather updates, inputs from various sources, and information on movement of relief materials by air, sea and road also pour into the control room for effective single-point coordination and to ensure that the needy gets assistance.

The toll-free numbers and landlines in the control room that were getting 300 to 400 calls daily are not that busy now, indicating completion of rescue

operations. The wireless unit of the Kerala Police, managed by a six-member team, that functions from outside the control room is still busy.

Besides P.H. Kurian, Additional Chief Secretary and State Relief Commissioner, who heads the control room, Shekar L. Kuriakose, Head, State Disaster Management Authority (SDMA), and Rekha Nambiar, Superintendent, National Disaster Response Force (NDRF), are the key persons.

The Kerala Police team is led by ADGP (Coastal Security) Sudheesh Kumar and assisted by Dy.SPs Sheen Tharayil and R. Dathan. Senior officers of the Indian Army, Air Force, Navy, Coast Guard, BSF, CRPF, Kerala Fire and Rescue Services, Revenue, and Motor Vehicles Department were all part of the team and are still playing an active role.

Green process cuts water use, pollution in textile industry

A completely green method developed by researchers from the University of Calicut, Kerala, can potentially do away with using water for sizing and desizing cotton and polyster yarn. Textile industry is highly water-intensive and also one of the biggest water polluters.

By using liquid and supercritical carbon dioxide instead of water, and sucrose octaacetate in place of starch, team of researchers led by Dr. Poovathinthodiyil Raveendran from the University's Department of Chemistry has made the sizing and desizing process eco-friendly. The results of the study were published in the journal ACS Sustainable Chemistry & Engineering.

Before the yarn is woven into fabric, it is coated with sizing agents to strengthen the yarn (to decrease breakages on the loom) and protect it from damage and reduce friction. Sizing also removes or smoothens the projecting microfibres that might interfere with the weaving process.

Traditionally, starch mixed in water is used for the sizing process, and this requires plenty of water. The used water is disposed of, leading to water pollution. "So we looked at changing the sizing process from a wet to a completely dry process," says Dr. Raveendran. The researchers used liquid carbon dioxide as solvent and tested three agents that easily dissolve in carbon dioxide for sizing both cotton and polyester yarn.

Best agent

"Of the three agents tested, we found sucrose octaacetate produced the best results," says Dr. Raveendran. The yarn had a smooth, glassy coating on the surface and the strength of the yarn (cotton and polyester) nearly doubled

and the yarn exhibited improved mechanical properties essential for weaving. All the microfibres that protrude from the yarn were aligned and smoothened. The abrasion resistance also increased upon sizing.

The yarn after sizing has to be dried when water is used, making the entire process energy-intensive. But no drying is needed when liquid carbon dioxide is used as it is an inherently dry process. When the pressure of carbon dioxide is reduced to gas phase pressure, the carbon dioxide changes its state from a liquid to gas leaving the yarn dry. "The yarn becomes dry instantaneously," he says.

Once the weaving is completed, the sizing agent has to be completely removed from the yarn as it might resist dyes and chemicals commonly used in textile processing. In the conventional desizing process, large volume of water is used for desizing or washing the fabric to remove the sizing agent from the yarn, which generates lots of waste water.

Instead of water, the researchers used supercritical carbon dioxide for desizing. "While both liquid and supercritical carbon dioxide have lower viscosity and surface tension compared with water, the molecular diffusion of supercritical carbon dioxide is 10 times more than liquid carbon dioxide," says Dr. Raveendran. "The more the molecular diffusion, the faster will be the movement of molecules in the fluid and this determines the efficiency of cleaning." The sizing agent dissolves in the supercritical carbon dioxide when it comes in contact with it.

As in the case of sizing, the yarn (in the fabric) becomes dry almost instantaneously when the pressure of carbon dioxide is reduced to gas phase pressure after desizing. And the sizing agent separates out from the yarn and settles at the bottom.

"The best part of this process is that it is zero-pollution, zero-waste as both carbon dioxide and the sizing agent (sucrose octaacetate), which is modified cane sugar, can be recycled endlessly," says Dr. Raveendran. The researchers are next planning to scale up the process and are looking at setting up a pilot plant to test the green process.

7. Health and Medicine

Using multiple sclerosis drugs to treat pancreatic cancer

An FDA-approved drug currently used for treating multiple sclerosis has been found to be effective for pancreatic cancer. Researchers from Rajiv

Gandhi Centre for Biotechnology (RGCB), Thiruvananthapuram, in collaboration with Regional Cancer Centre in the city and NIMHANS, Bengaluru, found that the drug was also able to increase the efficacy of gemcitabine, the current standard drug for pancreatic cancer. The results of the study have been recently published in Theranostics.

The drug used to treat multiple sclerosis was found to act through a receptor called S1PR1 that is involved in lipid signalling and which regulates numerous cellular events such as cell growth, migration and vascular integrity.

"The precise role of the receptor in pancreatic cancer is still not clear and our study has brought out its importance. We found that the [multiple] sclerosis drug can bind to the receptor and alter the key cellular events and prevent the progression of pancreatic cancer," explains Dr. K.B. Harikumar, from the Cancer Research Program at RGCB and corresponding author of the paper. The sclerosis drug was also found to be a potent inhibitor of NF-kappaB, a transcription factor that helps in tumour progression.

The effectiveness of the multiple sclerosis drug when used together with the current pancreatic cancer drug was checked in mice models. The combination drug treatment was able to control various signalling molecules, thereby decreasing cancer cell proliferation and increasing apoptosis. It also helped produce higher levels of reactive oxygen species and inhibited the migration of the cancer cells. They also studied the genes involved in inflammation and immunity in pancreatic cancer and found that the combination drug regime activated a tumour-suppressor gene and downregulated another that is involved in drug resistance and decreased immunity.

Better clinical outcome

The team also addressed one of the major problems in pancreatic cancer known as desmoplasia, which is the presence of a rich collagen deposition around tumour. Collagen deposition leads to poor clinical outcome due to decreased delivery of the drug to tumor. "In fact, gemcitabine itself leads to desmoplasia thereby reducing its own effect. We found that the combination drug therapy reduced desmoplasia. The [multiple] sclerosis drug loosens up the tumour and aids gemcitabine to penetrate into the tumour thereby increasing the bioavailability of the cancer drug," adds Dr. Harikumar.

The combination strategy showed no toxicity to the normal human and mouse cell lines thereby pointing towards the promising possibility of using this for the treatment of pancreatic cancer.

"Repurposing existing drugs cuts down the time taken to bring drugs to clinical testing. Moreover, using combination drugs can reduce the dosage of the drugs thus reducing side-effects," explains Manendra Babu Lankadasari, PhD scholar at the Centre and first author of the study in an email to The Hindu.

IGIB find ways to reduce TB's tissue-damaging effects

It is generally believed that TB bacteria make the host cells accumulate triglyceride and become lipid-rich as bacteria prefer lipids for their nutrition. Now, using human macrophage cells researchers at the Institute of Genomic and Integrative Biology (CSIR-IGIB) have shown that when TB-infected macrophages undergo necrosis (where the cell ruptures when it dies) lipids and bacteria contained in the cells are released. The neighbouring cells — both healthy and TB-infected — take up the lipids thus leading to lipid accumulation.

"Our study brings a new facet to the way the field has been thinking about pathogenesis where it was believed that because the bacteria prefer lipids for their nutrition, they make the host cell become lipid-rich. Our work points to the relevance of the incident pathology — necrosis in a granuloma result in the development of lipid-rich foamy macrophages [presence of cells with large lipid-filled vacuoles]," says Dr. Sheetal Gandotra from the Cardio Respiratory Disease Biology Unit at IGIB and corresponding author of a paper published in the journal Frontiers in Immunology.

The ability to induce necrosis is peculiar to virulent TB bacteria. The avirulentMycobacterium bovis strain used in BCG vaccine is unable to cause necrosis; it triggers a programmed cell death (apoptosis) instead. Like the BCG strain, TB mutants that lack the capacity to induce necrosis also lack the associated capacity to induce necrosis-induced triglyceride accumulation in neighbouring cells.

When macrophages encounter TB bacteria they mount an inflammatory response wherein certain factors are secreted to help recruit other cells of the immune system to kill the bacteria. "For the first time we reported that foamy macrophages showed more inflammatory response than normal macrophages," says Dr. Neetika Jaisinghani from IGIB and first author of the paper. As a result of the inflammatory response more macrophages are recruited to the site of infection thus exposing them to infection.

"So it sets off a positive feed-forward loop such that the inflammatory response gets amplified," says Dr. Gandotra.

To understand the role of excess lipids in host defence strategies, the researchers added uninfected necrotic cells to macrophages that were not infected with TB bacteria. Even these healthy macrophages stored lipids from the dying cells in the form of triglycerides. The macrophages were foamy but not infected. “These macrophages did not show any inflammation till such time they were infected with TB bacteria,” says Dr. Gandotra.

Human blood monocyte-derived macrophages, too, showed increased inflammatory response when triglyceride accumulation was increased. Central to the storage of triglycerides in macrophages is the DGAT1 enzyme (diacylglycerol o-acyltransferase). When the DGAT1 gene is silenced in the macrophage cell lines, the macrophages’ ability to accumulate triglycerides is compromised.

“Our studies show that macrophages made to store triglyceride in response to necrosis are able to mount a higher level of the inflammatory response, and if we deplete the levels of the DGAT1 enzyme, the inflammatory response of these macrophages to infection is suppressed,” Dr. Gandotra says. “Inhibitors are available against this enzyme and we plan to undertake preclinical studies.”

While the ability of the host to inhibit TB infection might not be compromised, the tissue-damaging effects of inflammation may be reduced by inhibiting the ability of the macrophages to accumulate lipids. “The work brings out the importance of the role of host lipid metabolism in increasing inflammation by foamy cells during infection, thereby bringing metabolism into perspective as a potential target for TB therapy,” Dr. Gandotra says.

“Currently, all anti-TB drugs are antimicrobials and don’t help in improving the respiratory health of TB patients, which is compromised. We are hoping that our research may help in finding a promising target to reduce inflammation in TB patients,” says Dr. Jaisinghani.

The role of lipids in altering the immune state in non-infectious metabolic disorders such as obesity is well known. But this study for the very first time reports the role of triglyceride metabolism in altering the immune state during infection.

TIFR researchers show how liver regulates outflow of fat

A grammar textbook example of a pun is the sentence “Life depends on the liver”. Indeed, the liver is a very important organ in the body since it regulates the metabolism of, among other things, fat in the form of lipid droplets.

Lipid droplets accumulate in the liver during "fasting, as in during sleep. Yet, the liver controls the release of these lipid droplets into the blood, thereby preventing excessive deposition of very low density lipids (VLDL) into the blood stream which could lead to heart disease. While this role of the liver is well known, the question of how it happens has not been addressed until recently. This question was taken up by Roop Mallik's group at the Tata Institute of Fundamental Research, Mumbai.

In a paper published in Proceedings of the National Academy of Sciences, US(PNAS), the researchers led by Dr Mallik show that the motor protein kinesin transports lipid droplets to the endoplasmic reticulum within the liver cells, from where it is secreted into the blood. During fasting, kinesin is removed from the lipid droplets, and this ensures they do not reach the endoplasmic reticulum, nor are they secreted into the blood. This tempers the secretion of lipids from the liver during fasting and protects the organs.

In their first experiment, the group of researchers extracted lipid droplets from cells and watched them move in a test tube. There they found that when they added specific compounds that blocked the motor protein kinesin, the droplets stopped moving. "This is how we found for the first time that kinesin is a key factor," says Dr Mallik. They published these results in the journal Nature Methods. Following this study, they experimented with rats and found the connection between regulation of lipid transport within the liver cells and that of the motor protein kinesin.

Reactive droplets

They found that the protein ARF1 (ADP-ribosylation factor 1) increased the breakdown of fats in the lipid droplets. It binds to the droplets and pinches off phospholipid molecules from their surface, thereby increasing their surface tension. This makes the droplets "reactive" and they interact more strongly with the endoplasmic reticulum. "We showed that high insulin in the fed state causes both ARF1 and kinesin to bind together to lipid droplets. This means that reactive droplets will be selectively transported to the smooth endoplasmic reticulum at the periphery of liver cells," says Dr Mallik. Because of this, the reactive droplets can interact with the smooth endoplasmic reticulum and supply fat for the assembly of VLDL particles inside the endoplasmic reticulum. "These fatty VLDL particles will be subsequently secreted out from the liver into blood, and the fat inside will be used up in other tissues of the body to generate energy," he explains.

The research is relevant in times when heart disease, for instance, is such a common ailment, also aggravated by faulty diets. Revealing plans for the future, Dr Malik says, "We hope to find molecules which can change the affinity of kinesin to lipid droplets. These molecules are potential drugs that

reduce fat secretion from the liver and therefore reduce the amount of fat circulating around in blood. This fat is a major cause of heart disease, diabetes and obesity."

FDA approves drug to treat smallpox

The US Food and Drug Administration (FDA) approved the first drug with an indication for treatment of smallpox on July 14.

Smallpox, a contagious and sometimes fatal infectious disease, was declared eradicated in 1980 by the World Health Organization. However, there have been longstanding concerns about smallpox.

Antiviral treatment

TPOXX (tecovirimat) is a small-molecule antiviral treatment for smallpox, the first therapy specifically approved for this indication.

"To address the risk of bioterrorism, Congress has taken steps to enable the development and approval of countermeasures to thwart pathogens that could be employed as weapons. This approval provides an important milestone in these efforts. This new treatment affords us an additional option should smallpox ever be used as a bioweapon," Scott Gottlieb, FDA Commissioner, said in a statement.

TPOXX's effectiveness against smallpox was established by studies conducted in animals infected with viruses that are closely related to the virus that causes smallpox.

More animals treated with TPOXX lived compared to the animals treated with placebo. Further, TPOXX's safety was also evaluated in 359 healthy human volunteers without a smallpox infection. The most frequently reported side effects were headache, nausea and abdominal pain.

TPOXX also received Orphan Drug designation. This provides incentives to assist and encourage development of drugs for rare diseases and a Material Threat Medical Countermeasure Priority Review Voucher, which provides additional incentives for certain medical products intended to treat or prevent harm from specific chemical, biological, radiological and nuclear threats, the statement said.

IISc researchers find cholesterol helps bacterial toxins kill cells

Researchers at the Indian Institute of Science (IISc), Bengaluru, have found that cholesterol present in cell membrane plays a crucial role in stabilising and binding together the pore-forming toxin cytolysin A. The pore-forming toxins form the largest class of bacterial proteins causing virulence that kills human cells. The cytolysin A toxin is secreted by E. coli, Shigella and Salmonella.

The toxin secreted by E. coli bacteria is water-soluble and binds to the cell membrane. The binding of the water-soluble toxin to the cell membrane does not depend on cholesterol present in the membrane surface. In fact, the binding drops in cholesterol-containing membranes. "Binding is only a part of the pore forming process and cholesterol has no role to play," says Dr. Rahul Roy from the Department of Chemical Engineering at IISc who led the team.

Toxin movements

Once the toxin gets bound to the cell membrane, it does not stay in one place. Instead, it keeps moving around the cell membrane surface. Using a powerful microscope that allows them to look at single molecules tagged with a fluorescent tag, the researchers could actually see the toxin proteins moving around.

Unlike the usually observed Brownian movement, these proteins tend to move around fast and then slow down before picking up speed and moving fast again. This happens even when no cholesterol is present. The structure capable of puncturing the cell membrane is supposed to slow down the protein movement. So this suggested that the structure of the bound protein is similar to the water-soluble protein and different from the structure that pierces the cell membrane.

Cholesterol interaction

In the presence of cholesterol, the protein stops moving quickly. "Using molecular dynamic simulations, we found cholesterol interacting with the protein just as we suspected. The interaction was with the region on the protein that is responsible for forming the pore," says Dr. Roy.

Binding to cholesterol per se does not stop the motion of the protein. But on binding to cholesterol, the structure of the protein undergoes a change resulting in slowing down of the motion.

The change in the speed of motion happens even in the absence of cholesterol due to the change in structure of the protein. But in the absence of cholesterol, the protein is unable to maintain the structure required for pore formation.

"The structure of the toxin is stabilised in the presence of cholesterol and that is essential for pore formation," says Pradeep Sathyanarayana from the Centre for BioSystems Science and Engineering at IISc and first author of a paper published in the Proceedings of the National Academy of Sciences. "This is a clever strategy by the bacteria to use the toxin to specifically target only human/animal cells while the bacteria themselves are protected from the toxicity since cholesterol is absent in bacterial membranes."

To be able to rupture the cell membrane, the proteins bound to cholesterol have to come together to form a ring-like structure comprising 12 molecules. The coming together of the molecules to form the ring-like structure is also enhanced in the presence of cholesterol.

"Computer simulations showed that when two pore-forming protein molecules come together there is a small pocket where the cholesterol goes and interacts with the proteins. So cholesterol provides additional support to hold the two molecules together," says Dr. Roy.

Studies by other groups have shown that cancer cells in mice can be reduced dramatically by using cytolysin A toxin.

"Based on our study, we can work on making the toxin target only the cancer cells. We can also use cholesterol-like molecules to prevent the toxin protein from changing its structure thereby prevent cell destruction," says Dr. Roy.

Emerging antimicrobial resistance in leprosy

A six-year study carried out across 19 countries has now shown that antimicrobial resistance is emerging in leprosy cases. This global data shows that a total of 8% of the Mycobacterium leprae bacterial strains studied showed gene mutations conferring resistance towards drugs such as rifampicin, dapsone and ofloxacin. Rifampicin resistance was observed in about 5% of the relapse cases and in 2% of the new ones. India and Brazil topped the list with more than 10 rifampicin-resistant cases each.

Molecular methods

Assessing antimicrobial resistance has not been possible so far as M. leprae does not grow in vitro. "Currently, there are only two techniques for studying M. leprae - the mouse foot-pad technique and genetic analysis. As the former is time-consuming, we used molecular methods for detecting the resistance genes," explains Dr. U.D. Gupta, National JALMA Institute of Leprosy and other Mycobacterial Diseases, Agra, and one of the authors of the paper published in Clinical Microbiology and Infection.

Global data showed that among the 1,932 (1,143 relapse and 789 new) cases studied, 3.8% showed gene mutations showing resistance to rifampicin. The number was 4.5% for dapsone and 1.1% for ofloxacin.

Certain cases showed resistance to more than one drug. Globally, 20 cases showed rifampicin and dapsone resistance, four showed ofloxacin and dapsone resistance. “Interestingly there were no cases of resistance to rifampicin and ofloxacin together. More studies are needed to know in depth about this,” he adds.

In India, the study was carried out in five laboratories across the country. Among the 382 cases studied from India, 4.7% showed resistance to rifampicin, 6.4% dapsone resistant and 4.4% ofloxacin resistant.

“In 1982, the multi-drug strategy was adopted to treat leprosy just when resistance to the then used drug, Dapsone was emerging. But now after almost four decades, we are noticing rifampicin resistance. Though the numbers are not alarming, it is essential to continue monitoring,” explains Dr. Joydeepa Darlong, Head of Research at The Leprosy Mission Trust of India. “Relapse cases may be under-diagnosed as we rely on self-reporting and there is decreasing leprosy expertise.”

“Unlike the routine regime (rifampicin, dapsone and clofazimine) administered once a month and given free of cost, the alternative drug regime (minocycline and ofloxacin) given to drug-resistant patients is a daily dose, prescribed for two years, and is very expensive. The government has no provision to provide this free of cost,” says Dr. Mallika Lavania from Stanley Brown Lab of The Leprosy Mission Trust of India and one of the authors of the paper. “Now, with the emergence of antimicrobial resistance, it also stresses the need for immediate notice, routine investigation and establishment of proper treatment guidelines by the government.”

“This is also a call for vigilance on the global use of antimicrobial agents, because ofloxacin resistance probably developed in relation to the general intake of antibiotics for other infections as it is not part of the multidrug combination used to treat leprosy,” adds the report. Ofloxacin resistant cases were found to be the highest in India among the 19 countries studied.

Antimicrobial resistance monitoring is now one of the core areas in the Global Leprosy Strategy for 2016–2020 and WHO has recently released an updated guide on surveillance of antimicrobial resistance in leprosy.

AIIMS-led team develops highly sensitive, portable test for TB meningitis

A diagnostic test for TB meningitis (the most severe form of TB) with nearly 100% sensitivity and about 91% specificity has been developed by a multi-institutional team led by Prof. Jaya Sivaswami Tyagi from the Department of Biotechnology at AIIMS. The performance of the diagnostic test was evaluated in 87 cerebrospinal fluid samples obtained from paediatric subjects (39 TB meningitis patients and 48 controls). The results of the study were published recently in the journal Tuberculosis.

The diagnostic test is based on a derivative of a DNA aptamer (a small single-stranded DNA molecule that binds to a specific target molecule and is a chemical rival of antibodies) that shows high binding affinity in nanomolar range and high specificity to a TB antigen (HspX). Besides higher binding affinity, there is significantly higher load of the HspX antigen in cerebrospinal fluid samples, leading to higher sensitivity.

A rapid, point-of-care diagnostic test for TB meningitis that uses the DNA aptamer has already been adapted to a sensor format and is being evaluated on clinical samples. “It takes all of 30 minutes to get the result as we are using an electrochemical sensing platform,” says Prof. Tyagi.

“While antibodies have to be generated in animals and so will not be of uniform quality, aptamers can be produced in the lab,” says Dr. Tarun Kumar Sharma from the Centre for Biodesign and Diagnostics at Translational Health Science and Technology Institute (THSTI), Faridabad and the other corresponding author of the paper.

The currently used diagnostic methods — microscopy and culture of cerebrospinal fluid — suffer from huge limitations in terms of poor sensitivity and long turnaround time of up to eight weeks. Even GeneXpert has only 55% sensitivity. In settings such as India, where the prevalence of TB meningitis is high, one in six patients tested by Xpert will be missed.

Ten-year journey

It has taken the team about 10 years to reach this stage of developing a diagnostic test. Since there are very few bacteria in TB meningitis samples, the researchers wanted to evaluate the utility of using TB DNA for the diagnosis using PCR. In a paper published in 2009 in the Journal of Medical Microbiology,the researchers filtered 167 cerebrospinal fluid samples using a filter paper and studied the filtrate that contains the DNA of TB bacteria. DNA and other components of TB bacteria are present in the filtrate due to disintegration of the bacteria.

“We studied TB bacteria present on the filter paper and the TB DNA present in the filtrate and found TB DNA yielded significantly higher sensitivity of

detection (88%) than the whole bacteria (53%). When we saw the filtrate had more DNA we wanted to check for antigens of TB bacteria," recalls Dr. Sagarika Haldar from the Centre for Biodesign and Diagnostics at THSTI and first author in two papers.

In a paper published in 2012 in PLOS ONE, the team studied 532 cerebrospinal fluid samples collected from children and looked for five TB antigens. "Though DNA and antigen were significantly higher in the filtrate compared with TB bacteria, the amount of TB antigens was far higher than DNA," Dr. Haldar says. Using DNA for diagnosis would involve sophisticated instrument and amplification while antigen detection will be straight forward.

The team found the sensitivity of both tests — DNA and antigen — was similar. Of the five antigens, two were found to be excellent in terms of sensitivity and specificity. "We would need an ELISA reader to detect the antigens. Since we wanted to make a point-of-care diagnostic test for TB meningitis, we turned out attention to DNA aptamers," says Dr. Haldar.

Using a DNA aptamer to bind to the TB antigen makes ELISA reader redundant in a portable assay format. The aptamer is also more sensitive, specific and stable compared with the antibody. Since the antigen is directly detected, only 5 microlitre of the sample is required.

Twenty-one aptamers were selected from the aptamer libarary and based on specificity one was chosen. Since all the 44 nucleotides of the aptamer don't interact with the HspX TB antigen, the size of the aptamer was reduced to 28 nucleotides. Reducing the size of the aptamer will in turn reduce the cost of the diagnostic test.

"Once the mutation was done to reduce the size we found the binding improved. The mutant aptamer showed 2.5-fold higher binding than the parent aptamer," says Abhijeet Dhiman from the Department of Biotechnology, AIIMS and first author of the 2018 paper. The optimised aptamer was tested on 87 cerebrospinal fluid samples and found to have nearly 100% sensitivity and about 91% specificity.

Traffic jams in the brain

Neurons transport cargo of various sizes constantly, and many times, this can lead to traffic jams. A new study of the roundworm (Caenorhabditis elegans) and fruitfly (Drosophila) shows that such traffic jams can be due to purely physical constraints, not involving any chemical signalling processes. Such stalling of cargo can happen in neurons afflicted by neurodegenerative diseases.

A recent study shows that it can happen even in normal cells. This could be a method adopted by the neuron to regulate the flow of mitochondria, vesicles containing neurotransmitters, and the like, along the length of its axon. The axon is the long arm of the neuron, which reaches out to the synapse or nerve endings. The study is published in the journal Traffic.

The researchers compare this to Indian roads. On the road, there are vehicles of several sizes and people walking, all moving on the same narrow lane. If one of these vehicles should stop for some reason, traffic tends to pile up temporarily. It eases out once the vehicle moves on and the traffic jam is cleared. Similar traffic jams of cargo happen in the axon.

Eureka moment

"It was really exciting to see that such traffic jams can happen among the tiny cargo in the brain," says Parul Sood, first author of the paper, who is a research scholar at Tata Institute of Fundamental Research in Mumbai. When the team was brainstorming to find a way of demonstrating this, she had a "Eureka!" moment: "I quickly went through my data to see if vesicles rushed through the location from where a stationary cargo — the presumed physical block — mobilised, and they did, showing that indeed vesicle motion was physically blocked at that location!"

Apart from the cargo, there are bits of cytoskeleton floating in the body of the axon. This includes microtubules, which are like roads for the cargo to move along. The cargo can halt for any reason, it could be that it has fallen off a microtubule or that it has arrived at the end of the microtubule, or some other reason, leading to an accumulation of cargo.

Dr Sandhya Koushika of TIFR, Mumbai, a co-author, and in whose lab the experiments were performed, explains, "We found that there were particular locations in the cell which were susceptible to forming these accumulations. The most susceptible regions were those that were actin-rich. When you have concentrations of actin, in this region when the cargo stalls, it's a double whammy. The amount of space allowed for the cargo to move has really shrunk."

Regulating mechanism

This could be a way to regulate the traffic down the axon. Dr Gautam Menon, from The Institute of Mathematical Sciences, a co-author of the paper, draws an analogy to the Mumbai-Chennai highway. "Suppose you are making things in Mumbai and sending them down to Chennai. Now suppose you want more stuff, you don't want to send a signal all the way up to Mumbai," he says. An efficient way to regulate this is to park it along the

way in different locations, and summon the cargo when needed. This is not a static accumulation but dynamic.

“Many people, especially biologists, are not greatly attracted to the idea that you may not have classical regulation… [where] something turns on, something turns off and there are changes in levels of protein etc. Here we show it can happen in perfectly healthy neurons with no changes in levels of proteins,” adds Dr Koushika.

Social factors too define skin colour of Indians

Skin colour variation in Indians is determined not just by the environment and genetics but by sexual selection, too. A complex interaction between physical and social forces is responsible for patterns of skin colour seen in males and females in India, says a study by CCMB researchers who collaborated with an international team.

The researchers looked at how skin colour varies between 10 different socio-cultural populations varied within and between the populations in Andhra Pradesh, Tamil Nadu, Uttar Pradesh and Bihar. They also looked at variation in skin colour between males and females within and between populations. Then they studied the influence of ultraviolet radiation on skin colour and finally looked at the variations with respect to genetic data.

“Our study showed that social factors along with genetics played a strong role in shaping skin colour diversity across India,” says Dr. Kumarasamy Thangaraj from the Centre for Cellular and Molecular Biology (CSIR-CCMB), Hyderabad and a coauthor of a paper published recently in the American Journal of Human Biology.

Greater pigmentation and hence darker skin helps protect the skin from harmful UV rays near the equator while less pigmentation leading to lighter skin colour promotes season UV ray-induced vitamin D production in people living in higher latitudes. Women generally tend to have lighter skin than men highlighting the importance of cutaneous vitamin D production for enhanced vitamin D absorption during pregnancy and breast feeding.

For the study, the researchers compared the skin colour data of people living in Hyderabad and belonging to five different castes, three castes in Tamil Nadu, and from Brahmins living in Uttar Pradesh and scheduled caste living in Bihar.

Melanin index

The melanin index of people samples in Andhra Pradesh showed wide variation — 33.4 to 53. Three agricultural castes (Kapu, Naidu and Reddy) in the State had similar skin colour while Brahmins had far lighter colour and merchant caste (Vysya) had darker skin. In Tamil Nadu, Brahmins and Saurashtrians had lighter skin colour than pastoralist Yadava caste. Brahmins in Uttar Pradesh had fairer skin than scheduled caste in Bihar, and their melanin index range was nearly similar to their counterparts living in Andhra Pradesh. The melanin index range of scheduled caste in Bihar varied widely — about 46 to 79.

"Clear differences in skin colour in men and women were seen," says Dr. Thangaraj. Males belonging to the three agricultural castes in Andhra Pradesh showed darker skin than women. Even among Brahmins in the State, women had a lighter colour than men and there is greater difference in skin colour between the sexes. Though the merchant caste (Vysya) had darker skin than the other four, they showed the least difference in skin colour between women and men. The same differences and similarities were seen in the case of Brahmins in Uttar Pradesh and scheduled caste in Bihar.

"We need to undertake a more detailed study by increasing the sample size, analysing few more genetic loci and including specific micro epidemiological factors that might be influencing skin colour for better understanding," says Dr. Anushuman Mishra on less skin colour difference between women and men among Vysya population. Dr. Mishra is from CCMB and coauthor of the paper.

The environment apparently plays a smaller role (16%) in determining skin colour in Indians, while social factors could explain 42% variation in skin colour. "This result is consistent with the observation that in India skin colour varies markedly even among populations living in the same geographic location," they write. And the difference in skin colour in two north Indian populations that live close to each other and share important genetic history suggests that population-level variation have a role in skin colour.

Role of gene variant

In Europeans, the SLC24A5 gene variant rs1426654-A is usually associated with lighter skin colour. But in the case of the scheduled caste population in Bihar the gene variant was found in "unusually high frequency" despite the population having dark skin. Similarly, in the case of UP Brahmins, despite the frequency of this gene variant being high, it did not have a significant effect on melanin index variation within the population.

"Our study suggests that there could be other genetic variant(s) in scheduled caste population in Bihar that have the ability to override the skin lightening effect of the gene variant rs1426654-A," says Dr. Thangaraj. "When we look at melanin index and the genetic variant together we find in addition to genetics, the social and environment factors also play a major role in determining the skin colour of a population."

The authors conclude that numerous migrations into India and admixture of populations might have provided sufficient room for novel genetic variants that determine skin colour to emerge and spread among people in India, thus overriding natural selection.

And the population-dependent sexual selection for lighter skin and endogamy practised in India has ensured that skin colour variation has been maintained between different populations.

Elephants wake up their sleepy genes to protect against cancer

Cells in our body have built-in mechanisms to be healthy, to correct errors, and to divide and grow to optimum size and make more copies of themselves. Each of these processes is strictly governed. But what if something goes wrong due to external insults, such as smoking, or high doses of radiation? Cancer is one such result, wherein the DNA in the cells is damaged, leading to non-stop multiplication and formation of uncontrolled large masses of tumour tissues, debilitating organs in the body. There are relevant genes and their proteins in the cells which attempt to resist such tumour growth. A gene called TP53 is one such. It is when these check and control mechanisms are tampered with that cancer results.

Peto's Paradox

Let us also note that cell division is not error-proof. The more cells there are in a body, the more chances there are for such errors to occur — the growth error can override the protective mechanisms. Thus, if every cell has an equal chance of going cancerous, elephants which have many billions of cells in their bodies would be expected to have greater chances of getting cancer than us humans. But it turns out that elephants (with a typical body mass of around 4,800 kg) are found to have a cancer rate of 5–8%, compared to 11–25% in us humans. This is also true of whales (40,000 kg); they seldom get cancer. And the 600 kg manatees, also called sea 'cows' (because they are vegetarians, and live on water plants in tropical seas) too seldom get cancer. On the other hand, a mouse, which hardly weighs a few grams, is 3 times more likely to get cancer than us humans. Thus, there seems more an inverse correlation between body mass and cancer

probability. This inverse relationship was first noticed by Dr. Richard Peto of Oxford University about 70 years ago, and has come to be known as Peto's Paradox. Since then, quite a few scientists have been trying to unravel the reason behind this riddle.

A possible explanation to this paradox comes from studying the genome (the entire collection of genes in the body) of organisms. Over the course of evolution, animals such as mice, humans, manatees and mammoths have gathered a large number of genes. Many of these genes are active and generate the materials necessary for the functioning of the organisms. But if one looks at the genome carefully, one finds that anywhere between 2–20% of the DNA in the genome is hardly used at all. They are just there, not coding for any RNA or proteins, but accumulated as evolutionary, ancestral heritage or baggage. Biologists have impolitely called them 'junk DNA'. (It is estimated that over 97% of the genetic sequence in the human genome is 'junk'). Many of these do not carry a 'promoter' to activate them to function. If one were to activate these 'non-coding genes' by some mechanism, there could be extra functions that the cell might acquire.

Waking 'zombie' genes

It is this 'waking up' of such 'sleeping DNA' sequences that appears to be responsible for the remarkable ability of elephants to not get cancer. This suggestion has recently been made by a group at the University of Chicago, led by Dr. Vincent J Lynch, titled "A zombie LIF gene in elephants is upregulated by TP23 to induce apoptosis in response to DNA" (and published in Cell Reports 24, 1765-76, August 14, 2018; those interested in the paper may access it at https://doi.org/10.1016/j.cellrep.2018.07.042). By the way, the word 'zombie' is used here to describe a silent, sleeping gene, called LIF, in the elephant genome. Why zombie? This goes back to the folktale in the country Haiti, wherein a corpse is brought alive through voodoo or black magic, mainly for manual labour. (On an aside, it would have been better to call LIF a Kumbakarna gene. In some versions of Ramayana, Ravana's brother Kumbakarna went off to a deep, long-lasting slumber, thanks to a spoonerist mistake he made, but had to be woken up to fight the war and he did, making Sugriva unconscious. Kumbakarna was not a corpse, but just sleeping!)

The Chicago authors found that in the elephant genome, the silent gene LIF was 'woken up' by an anti-cancer protein molecule called p53. The gene LIF (which is known as leukemia inhibitory factor) acts against damage to the DNA in cells, which are damaged and thus become cancer-prone. And, the elephant genome has 10 copies of the LIF gene; compare that with just one copy that we have. Once it is woken up, LIF begins its job of looking out for

cells in the body whose DNA might have been damaged, making them cancer-prone. It then works with some partner proteins to kill off such damaged cells. This process is induced by the protein p53 (which is coded by the gene TP53), which is also known as an anti-cancer molecule. Elephants have 20 copies of TP53; compare this with just one copy that we humans have. In effect, elephants have reduced cancer risk by evolving extra tumour-suppressor genes.

Given that the zombie/Kumbakarna gene LIF can be upregulated, and thus lead to protection against cancer in pachyderms, should we not try and do this in humans? Sure enough, several teams are already thinking about it, once the Chicago team's paper appeared. There is a Lasker or Nobel prize waiting for this feat.

Drug target for neurodegenerative diseases and cancer discovered

Bhubaneswar-based researchers have discovered that activation of a particular protein (TRIM16) can turn out to be a potential therapeutic intervention strategy for neurodegenerative diseases such as Alzheimer's, Parkinson's and amyotrophic lateral sclerosis (ALS). At the same time, inhibiting this protein in cancer cells can bring about a reduction in tumour proliferation. The results were published in The EMBO Journal.

Studies carried out in test tubes and in mice models have shown that the protein has the ability to protect cancer cells from oxidative stress, and inhibiting this protein can therefore lead to reduced tumour growth.

Neurodegenerative diseases

Normally, about 30% of newly synthesised proteins in a cell can end up being misfolded, which are then degraded and removed from the cell. Genetic mutations and stress (both cellular and environmental) can increase the rate of misfolding. When the amount of misfolded proteins far exceeds the capacity of cells to degrade and clear them, the cells tend to aggregate the misfolded proteins to reduce toxicity.

Though protein aggregates are less toxic to cells, they too can turn toxic if the aggregates increase in number and size, which is what is seen in the case of Alzheimer's, Parkinson's and ALS.

A team of researchers led by Santosh Chauhan from the Cell Biology and Infectious Diseases Unit at the Institute of Life Sciences, Bhubaneswar, has identified a novel mechanism by which misfolded proteins form aggregates and get degraded in the cell.

They found the TRIM16 protein playing a role both in the formation of protein aggregates and in their degradation. Protein aggregates are formed when the TRIM16 protein activates a particular pathway (P62-NRF2), while protein aggregates get degraded when TRIM16 enhances a different pathway (autophagy). Autophagy is a process of degrading the unwanted material to clean the cells and keep them healthy.

"The current strategy is to use small molecules to enhance the autophagy process to destroy protein aggregates. But small molecules are non-specific and can target other pathways too," says Dr. Chauhan. "Pharmacological activation of TRIM16 protein, on the other hand, will be more specific for therapeutic targeting of neurodegenerative diseases." When more TRIM16 protein is produced by activation, autophagy gets enhanced leading to higher rate of protein aggregate degradation.

Cancer cell growth

Since cancer cells proliferate rapidly unlike normal cells, plenty of metabolic waste gets generated and accumulated inside cancer cells. In this study, the researchers have shown that cancer cells via TRIM16 can hijack both the autophagy and P62-NRF2 pathways to keep the cells clean and survive in harsh conditions. The P62-NRF2 pathway detoxifies the reactive oxygen species-related metabolic waste.

When the TRIM16 activity was reduced in cancer cells in vitro, the capacity to proliferate was reduced. "The cancer cells were able to grow normally when the researchers added (complemented) TRIM16 protein, thus validating the crucial role of TRIM16 in cancer cell growth," says Kautilya Kumar Jena from the Institute's Cell Biology and Infectious Diseases Unit and first author of the paper.

In the case of animal studies, the researchers first removed (knockout) the TRIM16 protein from cancer cells and then introduced the cancer cells into mice models.

"Compared with controls, tumour growth was drastically reduced in mice when cancer cells did not have the TRIM16 protein," says Dr. Chauhan. "If we pharmacologically decrease the activity of TRIM16 in cancer cells then tumour growth can be inhibited."

Mix together ginger and jaggery to fight viruses

This column writer recently had a severe attack of very bad cold and cough, and no amount of swallowing antibiotics and vitamin C helped. His wife, Shakti, then recalled her mother's traditional treatment, ground up a little jaggery and raw ginger, and asked him to have it three times a day. Lo and

behold, the cough and cold disappeared within a day or two! Looking back to see which of the two - jaggery or ginger - did the trick, the writer looked up at modern scientific literature, from where it was seen that the Chinese have a similar traditional medication, called Ge Gen Tang. This too has ginger and a sweet herb (kudzu roots) in it, and has been used for years to fight common cold and a variety of other conditions.

That ginger has remarkable medicinal properties has been well known and studied by many groups, particularly from India, China, Pakistan and Iran. That it has dozens of drug molecules has also been reported. A review way back in 1994 by Dr. C V Denyer and coworkers (J. Natural Products, 57(5), 658-662, 1994) listed as many as 12 major studies on the medicinal properties of ginger. Some of these point to its anti-oxidative properties, some show it to have anti-inflammatory effects, some to its ability to treat nausea, a few to its anti-emetic ability, and there is even a paper from the West Asian region suggesting that it may have a beneficial effect against dementia and Alzheimer's. And a group of Iranian researchers from Isfahan have reviewed the current evidence on several properties of ginger in health and physical activity (Intl. J. Prev. Med. 2013 Apr. 4 (Suppl 1):S36-S42), including its anti-cancer properties.

Anti-cancer components

Remarkably, several studies highlight its anti-cancer properties. Dr. Yogeshwer Shukla and Dr. M. Singh from the Industrial Toxicology Research Centre (now renamed as The Indian Institute of Toxicology Research), Lucknow have published a brief review on the cancer-preventive properties of ginger (Food Chem.Toxicol. 2007; 45: 683-90), which has suggested that the components 6-gingerol and 6-paradol might be the active molecules here. And a 2011 review by Dr. A M Bode and Dr. Z Dong, in the book 'The Amazing and Mighty Ginger- Herbal Medicine' lists at least 115 constituents in fresh and dried ginger, the major active principles being the gingerols and their derivatives. And a recent paper from Shanghai suggests that ginger enhances the antitumor activity of the anti-cancer compound 5-fluorouracil, and have suggested a possible mechanism for this (Liu et al, Cell Commun. Signal 2018; 16:7).

It is apparent from the above that ginger is a veritable treasure trove of medicines. But, getting back to our cold and cough, how does ginger help? The lead paper by Jung San Chang and others from Taiwan, published in 2013 (Journal of Ethnopharmacology, 2013; 145: 146-151) offers some information. They point out that fresh ginger has anti-viral activity; in other words, it can also fight viruses. Common cold is known to be caused by viral infection (and that is why the conventional antibiotics do not work here),

and two viruses are identified to be the causative agents. One of them is the human respiratory syncytial virus (HRSV). Chang and group studied the effect of fresh ginger on cell lines containing HRSV, and showed that ginger stimulates mucosal cells to secrete a compound that counteracts viral infection. That ginger has compounds that are effective against various viruses has been suspected, and the present work adds to it by showing that ginger stimulates anti-viral molecules in the cell (called anti-viral cytokines) to fight HRSV. Earlier work by Denyer and coworkers (J. Nat. Prod. 1994, 57:658-62) had shown that ginger has a molecule called beta-sesquiphellandrene which fights and overcomes the virus causing common cold.

In the current era of looking for better and more effective anti-bacterials and anti-viral compounds from natural sources, turning to traditional medicines, confirming their efficacy using today's methods and understanding them had become a buzzing field. China has taken a great lead in this field and a full- fledged School of Pharmaceutical Sciences at the State Key Laboratory of Natural and Biomimetic Drugs is operating at the Peking University, Beijing. It is particularly important that India does not lag behind, and encourages and promotes such activities through adequate funding and career-encouragement.

Tradition and today

India has a full-fledged ministry called AYUSH which supports research, clinical trials and related matters in ayurveda, yoga and naturopathy, unani, siddha and homeopathy. While this is a welcome move, we need the practitioners and researchers in these areas (largely traditional) to work closely with organic and pharmaceutical scientists (who use today's methods and technologies), so that the maximum benefit may be had. Recall how earlier organic chemists and pharmacologists (Saleemuzzman Siddiqui, T.R. Seshadri, K. Venkataraman, T.R. Govindachari, Asima Chatterjee, Nitya Nand - just to name some) had worked in close collaboration with botanists and traditional healers. If the Ministry of AYUSH teams up with the relevant arms of the Ministry of Science and Technology (such as DST, DBT, SERM), the Ministry of Health (ICMR, DHR) and the Ministry of Chemicals & Fertilizers (Dept of Pharmaceuticals), much advancement in a relatively short time can be had. After all, India has just as rich a tradition of traditional medicine, and a group of well equipped laboratories (as China) for such a pan-Indian, pan-ministerial collaboration to occur and pluck both low- hanging fruits and those at higher branches. For starters, we can initiate an immediate programme of looking for anti-virals from natural sources, just as the Chinese in Taiwan and Beijing have done.

Last, what does the jaggery do? People believe that it is to make the pungent ginger more edible. By itself, it is known to have 15-35% less sucrose that refined white sugar, much more minerals (Ca, Mg and Fe), and is thought to be good at fighting flu-like symptoms. Sadly though, not much research has been reported on the biochemical and pharmacological aspects of jaggery. Here then is another exciting research topic waiting to be studied.

Changing trends in childhood blindness in India

A recent World Health Organisation (WHO) report has estimated that, across the world, 19 million children are visually impaired and 1.4 million among them are legally blind. According to the National Program for Control of Blindness, the number stands at 8 out of 10,000 for childhood blindness in India.

A study conducted in two taluks in Karnataka has now pointed out that corneal blindness is no longer the leading cause of childhood blindness. But blindness due to unavoidable causes are on the rise. They found whole-globe anomalies (small eye or absence of eyes) and uveal coloboma (a gap or a defect in the inner layers of the eye) to be the main causes of blindness.

From August 2012 to December 2013, about 8,000 children below the age of 15 were screened in 30 villages and 25 urban wards in Tumkur district, Karnataka. Medical social workers enumerated and identified the children with eye defects and further examination was done by an ophthalmologist who was stationed in the area.

Eye defects were detected in about 550 children in the examined group and refractive errors - when the eye is not able to focus images due to changes in the length of the globe or the shape of the cornea - were the most common cause.

The study found that more than 25% of the blindness was caused by whole globe anomalies and 25% by uveal coloboma. The other causes include corneal xerosis, cortical visual impairment, and retinal problems. Corneal xerosis is dryness of the cornea, the most common cause being vitamin A deficiency. It shows up as a dry and lustreless cornea. In extreme cases, the cornea can turn white or sometimes ulcerate. Cortical visual impairment is a decreased visual response due to a neurological problem affecting the visual part of the brain. Retina problems usually cause day or night blindness and are mostly a hereditary disease.

Initial treatment was given to children with visual impairments. Those with refractive errors were provided spectacles and children with major

conditions were referred to a paediatric ophthalmologist at a tertiary hospital and treated there.

"In the 1990s, corneal blindness, caused by vitamin A deficiency, was the leading cause of childhood blindness. The National vitamin A prophylaxis programme has brought down the prevalence. But alarmingly, the number of [occurrences of] blindness due to unavoidable causes has gone up," explains Dr. Vasudha Kemmanu, consultant paediatric ophthalmologist in Narayana Nethralaya in Bengaluru and first author of the study published in the journalEye.

"Not much can be done in the case of eye injury during delivery or due to any damage to the cortical area of the brain. But we can establish low vision rehabilitative services before the child turns five years, where the child can be trained to use his vision to the best," says Dr. Bhujanga K. Shetty, Chairman at the hospital and one of the authors of the paper.

Dr. Vasudha further explains that consanguineous marriage could be one of the reasons for eye diseases causing blindness. Further studies are being carried out to understand the role of such marriages. "We found that in 34% of the kids with eye defects their parents were blood-relatives such as uncles and nieces," she adds.

AIIMS study finds 23% prevalence of hypertension among rural school children

A recent study conducted across primary and secondary schools in rural areas of four Indian states has revealed that about 23% of the children had high blood pressure (BP). The high prevalence of high BP in otherwise healthy schoolchildren turns the spotlight on the need for proper screening and management programmes.

A multi-institutional team led by doctors from All India Institutes of Medical Sciences (AIIMS), New Delhi screened over 14,000 children in the age group 5-15 years in Goa, Haryana, Gujarat and Manipur. Children with known medical complications were excluded from the study. Almost equal number of boys and girls were studied.

Of the 23% children with high BP, 13.6% exhibited systolic hypertension, 15.3% diastolic hypertension and 5.9% exhibited both.

Lifestyle changes

"Most of these elevated BP cases can be corrected with lifestyle modifications such as regular exercises, reduction in the intake of junk food," says Dr. Anita Saxena, Professor from the Department of Cardiology at AIIMS and the

corresponding author of the paper published in the European Journal of Preventive Cardiology.

The researchers found wide variation in high BP numbers depending on the location — at nearly 30%, Manipur had the highest prevalence, followed by Haryana (26.5%), Gujarat (13.6%) and Goa (about 10%).

According to the report, the prevalence was higher in the two states which have lower ambient temperatures over the year, while two with lower prevalence are closer to the ocean. "Higher humidity [in Gujarat and Goa] could have caused increased perspiration and hence salt and water loss from body," the study says. Ethnic variations and genetic factors could have also played a role.

Unlike in the case of adults, blood pressure cutoffs in children below 15 years depend on age, gender and percentile height. "This makes the process cumbersome and difficult for doctors and health-care providers," says Dr. Rajiv Narang, Professor at the Department of Cardiology, AIIMS and first author of the paper. "In an earlier study, we found that simple cut-offs of 120/80, 125/85 and 135/90 mmHg can be used to detect high blood pressure in children of ages 5, 10 and 15 years, respectively."

High BP in childhood can lead to early onset of heart diseases in adulthood and so there is an urgent need for early monitoring.

Obesity-linked hypertension seen in many western countries is now been seen in children in developing countries.

More studies in the Indian context and also newer aspects of hypertension like prenatal exposure to maternal stress and effect of traffic-related air pollution need to be examined.

Ban on oxytocin likely to be lifted

Gynaecologists and obstetricians across the country can now exhale in relief: the Drug Technical Advisory Board (DTAB) has recommended to the Union Ministry of Health and Family Welfare that the ban on the retail sale of the life-saving drug, oxytocin, may be lifted.

The DTAB, in its meeting on July 25, recommended that the Health and Family Welfare Ministry's notification on April 27, banning retail sale of the drug formulation, oxytocin, may be amended and that its sale and distribution for human use, under the Drugs and Cosmetics Act 1940 and Rules 1945, be continued.

The ban had been imposed citing the serious misuse of oxytocin in the dairy sector.

While it recommended lifting of the ban, the DTAB has not said anything about the Ministry's decision (vide notification dated June 27) that only a single PSU — Karnataka Antibiotics and Pharmaceuticals Ltd. — could manufacture and supply the drug across the country.

'Welcome move'

The DTAB recommendation has brought immense relief to gynaecologists and obstetricians, who had said that the ban on retail sale of the drug could affect its availability in hospitals and clinics in rural areas, where more women were likely to bleed to death post-partum in labour rooms.

"It is certainly a welcome decision. But the fact that a single PSU, KAPL, which has never manufactured oxytocin, continues to hold the monopoly in the manufacture, distribution and sale of an essential drug like this, raises important questions. Also, nothing has been said about the pricing of oxytocin by KAPL — at Rs. 17.78 (including GST) per five IU vial — when several private pharma firms were earlier supplying it for as low as Rs. 4.82. Several concerns remain still," a senior gynaecologist here said.

"In effect, the lower priced and time-tested oxytocin brands of private pharma companies will be replaced with the costly brand of KAPL, in the name of misuse of oxytocin," points out K. V. Babu, a physician and public health activist in Kerala.

Three north-eastern States emerge as new HIV hotspots

The good news is that there has been a steady decline in the number of HIV cases in India. The bad news is that Meghalaya, Mizoram and Tripura have emerged as the new hotspots for HIV, according to the Ministry of Health and Family Welfare.

Lok Sabha reply

In response to a question in the Lok Sabha, the Ministry attributed the reason for the rise in the incidence of HIV in the three northeastern States to the high-risk behaviour of Injecting Drug Users (IDUs), and unsafe sexual practices.

In four sites in Mizoram and one in Tripura, HIV prevalence was higher among IDUs, which for the rest of the country is 6.3%. At least in three places at Aizwal, Champhai and Kolasib, the prevalence of HIV in IDUs was 37.44%, 33.06% and 38.14% respectively.

HIV prevalence among female sex workers was higher at four sites — two in Tripura and one each in Mizoram and Meghlaya. At one site of Mizoram's Aizwal district, the prevalence of HIV was as high as 24.68%, compared with 1.6% for other sites in the country.

In the case of pregnant women visiting ante-natal clinics (ANC), six centres in Mizoram, two in Meghalaya and one in Tripura recorded HIV prevalence of more than 1%, compared with HIV prevalence of 0.28% among pregnant women visiting ANCs in other places in India surveyed in December 2017.

The HIV Sentinel Surveillance (HSS), a biennial study conducted by the National AIDS Control Organisation (NACO), is one of the largest regular studies in the world dealing with HIV in high risk groups of the population.

The HSS had referred that HIV prevalence in the context of ANCs in the northeastern States of Mizoram (1.19%), Nagaland (0.82%), Meghalaya (0.73%), Tripura (0.56%) and Manipur (0.47%) were among the highest.

Samiran Panda, Director of the National AIDS Research Institute (NARI), said that the discussion on HIV prevalence has to be taken to the districts. "We need prevention and intervention strategies for the most-at-risk population in these pockets, with good coverage," Dr. Panda said.

In terms of persons living with HIV (PLHIV) who are on Anti-Retroviral Treatment (ART), Dr. Panda said that almost 12.28 lakh people are covered under ART. According to him, the target is to bring 90% of the 21 lakh people living with the HIV infection in India under ART.

"Going by that target, we are still short of about 6 lakh patients. The challenge is to encourage more people to take the test and then provide them with ART," he said.

ART's efficacy

Interestingly, ART leads to effectively suppressing the virus and reducing the transmission of HIV from the infected person, Dr. Panda said.

In terms of PLHIV who are on ART, Maharashtra has the highest number (with 2.03 lakh persons) followed by A.P. (1.78 lakh) and Karnataka (1.58 lakh persons).

Most babies not breastfed in their first hour

As many as 6 out of 10 babies born in the country are not able to begin breastfeeding within one hour of birth despite an improvement in institutional deliveries due to a lack of supportive work environment,

inadequate skills of health care providers as well as caesarean deliveries, according to a new report made public.

First milk

Mother's breast milk within one hour of birth ensures that the infant receives the colostrum or first milk, which is rich in protective factors. The WHO and UNICEF also recommend exclusive breastfeeding for infants up to the age of six months and thereafter complementary foods with continued breastfeeding up to 2 years of age or beyond.

The 5th Report of Assessment of India's Policy and Programmes on Breastfeeding and Infant and Young Child Feeding in 2018 also gives India a score of 45 out of 100 on 10 parameters under the category of policy and programmes. However, India performs better in terms of infant and young child feeding practices scoring 34 out of 50 on five parameters.

The report has been prepared by a national consortium of public health groups and agencies including government departments, AIIMS and UNICEF, under the aegis of World Breastfeeeding Trends Initiative (WBTI).

Early initiation of breastfeeding within one hour of birth is 41.5%, exclusive breastfeeding for the first six months is 54.9%, inclusion of complementary feeding between 6-8 months is 42.7% and adequate complementary feeding and minimum acceptable diet among 6-23 months children is as low as 9.6%, the report cites data from NFHS-4.

Inching forward

India has made some progress over the years and between National Family Health Survey (NFHS)-3 and NFHS-4, early initiation of breastfeeding has improved from 23.4% to 41.5% children breastfed within one hour of birth.

This hasn't kept pace with the stark increase in institutional deliveries which more than doubled during the same period, from 38.7 % to 78.9%.

Govt allows oxytocin sale through private chemists

Setting aside its ban on the sale of oxytocin, the Health Ministry has allowed private retail stores to sell the life-saving hormone from September 1, an official said. State-owned Karnataka Antibiotics Pvt Ltd will be the only company to manufacture and distribute oxytocin in India from September 1. The government has already banned the import of oxytocin.

Astronomers puzzled by 'cow' in the sky

Astronomers across the world are puzzled by a new phenomenon — a very bright celestial object seen close to the very small galaxy CGCG 137-068 — reported in The Astronomer's Telegram on June 17. Since then, the journal has been receiving a spate of communications, from Indian astrophysicists, too. A fast-brightening spot, initially thought to be a bright transient astronomical event lying close to the galaxy CGCG 137-068, was spotted by the ATLAS telescope. Named AT2018cow, the transient was soon given the nickname 'cow'. This is not due to any resemblance to the quadruped but a mere coincidence of letters in the way of naming such transients.

The cow proved to be suitably interesting, because though it was initially thought to be a nova, later analysis showed that it was more like a broadline supernova of the type Ic. Transient astronomical events last from a few seconds to several weeks and may have several causes. Specifically, a Type Ic supernova is caused by the explosion of an extremely massive star which has lost its outer layers of hydrogen and helium.

"As part of the GROWTH collaboration, we are keeping an eye on the mysterious transient AT2018cow using the 2-metre Himalayan Chandra Telescope (HCT) at Hanle, Ladakh," says Shubham Srivastav, a post-doctoral fellow at IIT Bombay, in an email to The Hindu. The HCT observations indicate that the transient is steadily fading in all optical bands. Although spectroscopic features indicate a tentative similarity with broad line Ic supernovae, its true nature remains a puzzle, he adds.

A.J. Nayana, a research scholar at National Centre for Radio Astrophysics, Pune (NCRA) says: "We observed AT2018cow with the Giant Metrewave Radio Telescope (GMRT) on June 28 and reported our first results on June 29 in The Astronomers Telegram ." Since there are many transients being discovered each day, the researchers had to wait and decide if this object was worth the effort. Also, as Prof Poonam Chandra at NCRA, Pune, explains, "Radio frequencies are the lowest energy of the electromagnetic spectrum and the object evolves much later at radio frequencies. The GMRT results tell us that the radio-frequency radiation is still absorbed, most likely, by the relativistic electrons themselves which are responsible for the radio emission."

Astronomers are in a frenzy trying to figure out what this is. "Even if it is finally a Type IC supernova, it will not be a conventional one," says Varun Bhalerao from the Indian Institute of Technology Bombay, who is involved in

analysing data received from the GMRT as well as the Himalayan Chandra Telescope. "The images and spectrum were obtained by the Hanle facility and GMRT. We have requested Astrosat to observe and it will start on July 3," he adds.

In particular, AT2018cow's fast rise time and high luminosity are unprecedented for a supernova. Hence it seems like nothing that was known before. "Anything in the unknown territory becomes exciting, and hence currently difficult to explain. However, I am confident that as astronomy community collects more data in multiple wavelengths, we will be able to nail down this exotic supernova," says Prof. Chandra.

NASA prepares to extract data as Kepler runs very low on fuel

Scientists at NASA are preparing to download the latest bit of data stored in its planet-hunting Kepler space telescope as the spacecraft is now running "very low" on fuel. The U.S. space agency said it has placed the spacecraft in a no-fuel-use 'hibernation' mode.

Upgraded Vikas engine — with more thrust — will boost ISRO's rockets

All three satellite launch vehicles of the Indian Space Research Organisation (ISRO) are set to add muscle to their spacecraft lifting power in upcoming missions this year. The space agency has improved the thrust of the Vikas engine that powers all of them. The agency said the high-thrust engine qualified after a ground test lasting 195 seconds (over three minutes).

Main beneficiary

The main beneficiary of the high-thrust Vikas engine is said to be the heavy-lifting GSLV-Mark III launcher, which ISRO expects will now put 4,000-kg satellites to space. This would be the third Mk-III and the first working one to be designated MkIII Mission-1 or M1.

The first MkIII of June 2017 started with a 3,200-kg satellite and the second one is being readied for lifting a 3,500-kg spacecraft.

The Vikas engine "will improve the payload capability of PSLV, GSLV and GSLVMk-III launch vehicles," ISRO said. The improvement effort, the second such since December 2001, was conducted at ISRO Propulsion Complex in Mahendragiri, Tamil Nadu.

S. Somanath, Director, Launch Vehicles Centre, Vikram Sarabhai Space Centre, said the incremental benefit of the upgraded engine should be seen in the PSLV and GSLV missions over the coming months. MkIII-D2, the

second test flight of the heavy-lifter, is being assembled. The new engine will be used in the subsequent mission — M1.

The Vikas engine is used in the second stage of the light lifting PSLV; the second stage and the four add-on stages of the medium-lift GSLV; and the twin-engine core liquid stage of Mk-III.

Mr. Somanath said that, eventually, ISRO will phase out Vikas by replacing it first in Mk-III with a cleaner and safer semi-cryogenic engine. The semi-cryo engine is ready for trial; its stage has just been approved. "I cannot predict when it [the replacement] can happen," he said.

ISRO ropes in 3 partners

The Indian Space Research Organisation (ISRO) has roped in three partners to help it assemble 27 satellites at a quick pace over the next three years.

Three-year contracts

In Bengaluru, its nodal satellites division URSC (U.R. Rao Satellite Centre) signed separate three-year contracts with Alpha Design Technologies P Ltd and its six consortium members; with defence public enterprise Bharat Electronics Ltd; and with Tata Advanced Systems Ltd, Hyderabad.

27 spacecraft by 2021

Each partner will work with the URSC to produce three small to medium satellites each year, or a total of 27 spacecraft by July 2021, it is learnt. About 50 members from each partner will separately work with URSC engineers to complete the project.

The Alpha-plus consortium includes small and medium-sized companies such as Newtech, Aidin, Aniara Communications, DCX, Vinyas and Exseed Space, according to Alpha CMD Col. H.S.Shankar. All but the last members were already involved in building two 1,400-kg navigation satellites IRNSS-1H and 1I for ISRO last year. A URSC official signed the agreements with the three entities in the presence of URSC Director M. Annadurai.

NASA s Juno data points to new volcano on Jupiter moon Io

Using data collected by NASA's Juno spacecraft, scientists have got clues to a previously undiscovered volcano on the Jupiter moon Io. With its Jovian InfraRed Auroral Mapper (JIRAM) instrument, the Juno spacecraft found a new heat source close to the south pole of Io, NASA researchers said.

First lake of liquid water is discovered on Mars

A massive underground lake has been detected for the first time on Mars, raising the possibility that more water—and maybe even life—exists there, international astronomers said Wednesday. Located under a layer of Martian ice, the lake is about 12 miles (20 kilometers) wide, said the report led by Italian researchers in the US journal Science. It is the largest body of liquid water ever found on the Red Planet.

"This is a stunning result that suggests water on Mars is not a temporary trickle like previous discoveries but a persistent body of water that provides the conditions for life for extended periods of time," said Alan Duffy, an associate professor at Swinburne University in Australia, who was not involved in the study.

Mars is now cold, barren and dry but used to be warm and wet. It was home to plenty of liquid water and lakes at least 3.6 billion years ago.

Scientists are eager to find signs of contemporary water, because such discoveries are key to unlocking the mystery of whether life ever formed on Mars in its ancient past, or if it might persist today.

Being able to access water sources could also help humans survive on a future crewed mission to Earth's neighbouring planet.

This particular lake, however, would not be drinkable, and lies almost a mile deep (1.5 kilometers) beneath the icy surface in a harsh and frigid environment.

Whether microbial forms of life lie within is a matter of debate.

Some experts are sceptical of the possibility since the Mars water lake is so cold and briny, and mixed with a heavy dose of dissolved Martian salts and minerals.

The temperature is likely below the freezing point of pure water, but can remain liquid due to the presence of magnesium, calcium, and sodium.

"This is a discovery of extraordinary significance, and is bound to heighten speculation about the presence of living organisms on the Red Planet," said Fred Watson, of the Australian Astronomical Observatory.

"Caution needs to be exercised, however, as the concentration of salts needed to keep the water liquid could be fatal for any microbial life similar to Earth's," added Watson, who was not involved in the research.

The discovery was made using radar instruments on board the European Space Agency's Mars Express orbiter, which launched in 2003.

The tool is called the Mars Advanced Radar for Subsurface and Ionosphere Sounding (MARSIS), and was designed to find subsurface water by sending radar pulses that penetrate the surface and ice caps. MARSIS "then measures how the radio waves propagate and reflect back to the spacecraft," said the study.

These reflections "provide scientists with information about what lies beneath the surface."

Lead author Roberto Orosei of the Istituto Nazionale di Astrofisica in Bologna, Italy surveyed a region called Planum Australe, located in the southern ice cap of Mars, from May 2012 until December 2015.

A total of 29 sets of radar samplings showed a "very sharp change in its associated radar signal", allowing scientists to map the outlines of the Mars water lake.

"The radar profile of this area is similar to that of lakes of liquid water found beneath the Antarctic and Greenland ice sheets on Earth, suggesting that there is a subglacial lake at this location on Mars," said the report.

"This is the first body of water it has detected, so it is very exciting," David Stillman, a senior research scientist in the Department of Space Studies at Southwest Research Institute in Texas, told AFP in an email.

However, Stillman, who was not involved in the research, said another spacecraft, or other instruments, need to be able to confirm the discovery.

He noted that a higher-frequency radar instrument made by the Italian space agency, SHARAD, on board the Mars Reconnaissance Orbiter launched in 2005, and has been unable to detect subsurface water.

"It is strange that SHARAD cannot confirm this discovery. In fact, SHARAD cannot penetrate through the ice here and no one understands why it can't," Stillman said.

"This suggests that something strange is going on here. Thus, I'm sceptical about this discovery."

But researchers are excited about the potential for future finds, because if liquid water could be found at Mars' South Pole, it might be elsewhere too.

"There's nothing special about this location other than the MARSIS radar on the Mars Express spacecraft is most sensitive to that region meaning there

are likely similar water deposits below the ground all across Mars," said Duffy.

Star watchers count black holes in globular clusters

The universe is strange and fascinating because it holds many a glittering clue to its secrets — bright and dark. To follow the clues and unravel these secrets is the astrophysicist's privilege. In a recent paper published in The Astrophysical Journal, Sourav Chatterjee of Tata Institute of Fundamental Research (TIFR), Mumbai, and a team of international collaborators, trace such clues to estimate the number of black holes in globular clusters.

Globular clusters

Globular clusters are massive bunches of stars that are typically about 9-12 billion years old. While the Milky Way has about 150 globular clusters, their number could go up to a few thousands in other galaxies. They are densely packed with stars. Within the distance equal to that between the Sun and its nearest star neighbour, a globular cluster would have about a million stars. "Due to the high stellar densities, the stars interact with other stars frequently. These dynamical interactions are key to understanding how black holes form binaries that may be detected via gravitational waves, X-ray or radio emission," says Sourav Chatterjee in an email to The Hindu.

Recently, astronomers have detected black hole candidates in four globular clusters in the Milky Way. "They are either discovered via X-ray or radio emissions or by monitoring the radial velocity of a companion star," Dr Chatterjee explains. Among these, the team studied three globular clusters within the Milky Way: 47 Tuc, M 10, M22. These three globular clusters have candidates identified to be black holes through radio and X-ray observations. "The observations were done using archival data from the ACS survey done using the Hubble space telescope. All theoretical models and data reduction software were built by us," he adds.

This has sparked interest in understanding how these black holes evolve and estimating how many black holes are there within a globular cluster. The team shows that the clue to knowing the number of black holes in the cluster lies in the mass segregation observed between the giant stars and the less massive main sequence stars. They find that the measure of mass segregation is related inversely to the number of black holes in the cluster. According to Dr. Chatterjee, this can be an effective probe to indirectly estimate the number of black holes in a globular cluster aided by calibrations from numerical models.

Milky Way

The team has estimated that 47 Tuc, M10, and M22 globular clusters within the Milky Way contain 150, 50 and 200 black holes, respectively.

Not all black holes that form in a cluster are retained. Some of them are ejected at birth and some are forced out later. Once this has stabilised, the galaxy or cluster acquires a stable retention fraction.

"Newlin [N. Weatherford, a collaborator from North Western University, USA] and I will use the same method to constrain the number of retained black holes in all globular clusters for which the necessary data is available," Says Dr Chatterjee.

"These constraints will help us understand the retention fraction of black holes in globular clusters. This has wide implications. For example, the rate of black hole mergers observable by LIGO is dependent strongly on this [constraint]," he adds.

PSLV to launch 2 U.K. satellites tonight

A PSLV launch night will put two earth observation satellites from the U.K. to space.

There is no Indian satellite on this flight. PSLV-C42 will be the first fully commercial trip of the year, breaking a five-month-long lull for the Indian Space Research Organisation.

ISRO did not make any launch post-April 12, after it put replacement navigation satellite, IRNSS-1I to space on the PSLV-C41 rocket.

A few days after that, it recalled its GSAT-11 from the South American launch port of Kourou and weeks before it was due for a launch ISRO Chairman K. Sivan said the interval was not connected with the satellite recall but for the sake of readiness of the two customer satellites.

The countdown to the launch began at 1.08 p.m. . The PSLV is being flown in its core-alone format, minus the external boosters. The two satellites together weigh nearly 889 kg; this is the optimum payload that a core-alone PSLV can launch, Dr. Sivan said.

PSLV-C42 is scheduled for launch at 10.08 p.m. from the first launch pad of the Satish Dhawan Space Centre, Sriharikota. It will lift NovaSAR and S1-4 to a sun-synchronous ('pole-to-pole') orbit 583 km from Earth. The entire flight up to the release of the satellites is designed to happen within 17.5 minutes.

The satellites are owned by Surrey Satellite Technologies Ltd., which signed a commercial launch contract with Antrix Corporation, an ISRO release said.

ISRO launches two U.K. satellites

The late-night dark skies at Sriharikota lit up in bright orange hues as the PSLV-C42 lifted off and vanished into the thick black clouds, carrying two satellites from the United Kingdom – NovaSAR and S1-4 from the first launch pad at the Satish Dhawan Space Centre, SHAR here.

The lightest version of the PSLV, flying in its core-alone version without the six strap-on motors, the PSLV-C-42 rose into the skies at 10.08 p.m. Almost 18 minutes later, the two satellites were placed in the desired orbit by ISRO. This was the 12th such launch of a core-alone version of the PSLV by ISRO.

"This was a spectacular mission. We have placed the satellite in a very, very precise orbit," R. Hutton, Mission Director, said.

The two satellites, owned by Surrey Satellite Technology Ltd (SSTL) were placed in a circular orbit around the poles, 583 km from Earth. The commercial arm of ISRO, Antrix Corporation earned more than Rs. 220 crore on this launch.

The NovaSAR is a technology demonstration mission designed to test the capabilities of a new low cost S-band SAR platform. It will be used for ship detection and maritime monitoring and also flood monitoring, besides agricultural and forestry applications. The S1-4 will be used for environment monitoring, urban management, and tackling disasters.

"This unique mission is mainly for 'ascending daytime node' launch. This is the first time we have executed a different type of mission altogether," K. Sivan, Chairman, ISRO said.

Outlining the road map for ISRO, Mr. Sivan said the next six months will see 18 missions – 10 satellite missions and 8 launch vehicle missions.

"We are almost going to have one launch every two weeks. Definitely the load on us is going to be huge," he said.

Among the slew of launches scheduled over the next few months, the much-awaited and delayed, India's second lunar mission, Chandrayaan-2 finally has a launch window.

"Chandrayaan-2 is planned for a window from January 3 to February 16, 2019 that we are targeting. It can happen anytime during that window. But we are aiming for the beginning of the window, January 3," Mr. Sivan said.

"Right now with the status of the rocket, the GSLV Mk-3 M1, and the present status of the satellite, we are not expecting any more delay. At the same time tests are going on."

Sorting out disputes

"There are many incidents of border transgressions that are not being recorded by both sides. If it's reported, then it becomes part of the official record. The troops on both sides are communicating more and sorting out the differences," said the official.

As per an internal report accessed by The Hindu, from August 1-19, as many as 19 incidents of transgressions were reported, out of which 13 were in the Leh sector.

At least three intrusions were reported in Leh, Uttarakhand'sBarahoti and the strategically sensitive Asaphila in Arunachal Pradesh on August 15 when the two armies held a special Border Personnel Meeting at Nathu La in Sikkim.

An analysis of the report reveals that the transgressions are anywhere from 300 metres to 19 km in the Indian Territory.

The official claimed that there were only 10-12 locations along the China border which saw dispute.

ISRO to tap small cities for innovations

The Indian Space Research Organisation (ISRO) launched a space technology incubation centre in Tripura capital Agartala. It is the first of six such centres planned nationally to build capacity in new locations.

More such space research activities will be splashed in a big way across small cities to tap their talent and include them in the space footprint, ISRO Chairman K. Sivan, said.

The incubation centre will be located in the National Institute of Technology, Agartala. Inaugurating it from Bengaluru, Tripura Chief Minister Biplab Kumar Deb said it was time high technology programmes reached the remote northeast India.

The space agency's new Capacity Building Programme directorate will invest Rs. 2 crore in incubation facilities in Jalandhar, Bhubaneswar, Tiruchi, Nagpur and Indore.

"We want to go to locations that have a good presence of academia and industry but do not have activities related to space. The centres will bring

out prototypes and innovations for ISRO in electronics, propulsion and others. We will buy the innovations back if we can use them in our programmes," Dr. Sivan said.

Indian space market

He was speaking at the annual event of the India Electronics and Semiconductor Association (IESA), which has enlarged its ambit to space electronics this year.

Domestic industry should increase the production of critical electronics items needed in space and other programmes, as 75% of it is now imported, Dr. Sivan said.

IESA Chairman Anil Kumar Muniswamy said the Indian space market offers big opportunity to industry as it is estimated to grow to $1.6 billion by 2023.

ISRO setting up launch pad for Gaganyaan mission

The Indian Space Research Organisation (ISRO) is setting up a third launch pad at Sriharikota to undertake the Gaganyaan manned space flight programme, an ISRO official said on Friday. In addition, ISRO is scouting for a location on the western sea coast near Gujarat to set up another launch pad for Small Satellite Launch Vehicles (SSLV).

Third launch pad

"We have two launch pads currently, which are already full. A third launch pad is being set up for the human space flight. It will be ready in time for the mission," a senior ISRO official said.

In the Independence Day address this year from the Red Fort, Prime Minister Narendra Modi had announced that an Indian will go to space by 2022.

Following this, ISRO has announced an ambitious roadmap to put a three-man Indian crew in a low earth orbit for 5-7 days by the 75th Independence Day.

ISRO Chairman Dr. Sivan had stated earlier that ISRO has begun work on the manned mission in 2004, and that many of the critical technologies required for human spaceflight have already been validated through various tests — Space Capsule Recovery Experiment, Crew Module Atmospheric Re-Entry Experiment and Pad Abort Test.

ISRO will use its GSLV Mk-III launch vehicle, which can carry the heavier payload of the Gaganyaan, and this will take off from the new launch pad.

In addition to the third launch pad at Sriharikota, ISRO is also scouting for a new location near Gujarat for the SSLV.

ISRO is developing the SSLV to offer affordable launch options for smaller satellites through Antrix, the space agency's commercial arm. ISRO currently piggybacks smaller satellites on the PSLV and GSLV along with bigger satellites.

The SSLV is expected to reduce the launch time as well as cost less to launch small satellites, which are much in demand.

India's Mars probe completes four years in orbit: ISRO

India's maiden interplanetary mission — the Mars Orbiter Mission (MOM) — has completed four years orbiting the red planet, according to ISRO. The mission, launched on November 5, 2013, placed itself into the Martian orbit on September 24, 2014. Though the designed mission life of MOM was six months, it has been sending scientific data for four years.

Small launcher will have a big impact

A small Indian satellite launch vehicle that was made in three days by a handful of people at about 10% of current costs looks set to revolutionise the global satellite launch industry.

The SSLV (small satellite launch vehicle) is being developed at a furious pace at ISRO's Vikram Sarabhai Space Centre. The SSLV will be an on-demand rocket for small satellites weighing about 500-700 kg. It will be autonomous and highly intelligent, versatile and capable of adapting to different launch situations and requirements.

Its first test launch is planned for mid-2019. Once proven, the SSLV's production would be offered to industry through Antrix Corporation, according to ISRO Chairman K. Sivan.

The SSLV is said to be Dr. Sivan's dream concept for a quick-response space vehicle, and the project was initiated when he was the Director of the VSSC until January this year.

ISRO set to launch its TV channel

The Indian Space Research Organisation (ISRO) will have an year-long Vikram Sarabhai centenary celebration starting in August 2019 to honour the visionary scientist and legendary founding father.

In a few months' time, it plans to roll out a dedicated ISRO TV channel, showcasing space applications, developments and science issues, targeting young viewers and people in remote areas in their language.

Series of events

Sarabhai, the architect of the Indian space programme, the first ISRO chief and renowned cosmic ray scientist, was born on August 12, 1919.

ISRO's tributes to Sarabhai start with naming the first Indian moon landing spacecraft of the Chandrayaan-2 mission 'Vikram'. The mission is planned for early 2019.

A chair each at Sarabhai's two alma maters, Cambridge University and Gujarat University, as also at the Massachusetts Institute of Technology (MIT), would be set up, apart from giving awards, scholarships and fellowships in the country and abroad, ISRO Chairman K. Sivan said at a news conference , the 99th birthday of the legend.

Sarabhai was only 28 when he sowed the seeds of a space agency around the late 1940s and 1950s. "We have planned an year-long centenary of the visionary architect of the space programme and our first Chairman, Dr. Sarabhai, during 2019-20. A series of activities will be organised nationally and internationally to commemorate the great international scientist," Dr. Sivan said.

The events are being taken up with an initial outlay of Rs. 50 crore.

Earlier, former Chairman of ISRO K. Kasturirangan unveiled a new bust of Sarabhai at the remodelled atrium of the ISRO headquarters, Antariksh Bhavan.

Dr. Sivan said 100 lectures by science luminaries would be held across the country and in association with the International Astronautical Federation, the global space networking body. Space clubs, knowledge centres and talk shows are also among the plans.

Public satellite launches

As it strengthens its public outreach, ISRO will shortly start allowing the public to watch satellite launches from its Sriharikota launch centre. "We are opening our space port to visitors just as NASA (the U.S.' National Aeronautical and Space Administration) does," Dr. Sivan said.

Gaganyaan, India's first manned mission, set to be a reality by 2022

An Indian astronaut, be it a man or a woman, will go on a space odyssey by 2022 on board 'Gaganyaan', Prime Minister Narendra Modi said in his Independence Day address here.

He said when India celebrates 75th year of Independence in 2022, "and if possible even before, an Indian son or daughter" will undertake a manned space mission on board 'Gaganyaan' "carrying the national flag". Chandrayaan-1 was India's first lunar probe.

It was launched by the Indian Space Research Organisation in October 2008 and operated until August 2009. Mangalyaan is another Indian space project. The Mars Orbiter Mission (MOM), also called Mangalyaan, is a space probe orbiting Mars since September 24, 2014.

With human space flight, India to push frontiers

Gaganyaan, the human space flight Programme green-flagged and set for 2022 by Prime Minister Narendra Modi, is highly doable, Chairman of the Indian Space Research Organisation K. Sivan said here soon after it was announced.

V.R. Lalithambika, a specialist in advanced launcher technologies, will helm the project as Director of the Human Space Flight Project.

The mission is estimated at Rs. 9000 crore. Most of the critical technologies and hardware required for the project are ready or have been demonstrated by its centres. ISRO would now stitch them up into a complete project and present a comprehensive project report to get a formal approval of the government, Dr. Sivan said. "We have tested the necessary critical technologies required for the Human Space Flight Programme (HSP) and are confident of achieving it as stated by the Prime Minister," he said.

"We will now speed up the paper work and submit a project report for formal approval. We may immediately need around Rs. 2,000 crores for enhancing infrastructure and technologies at two or three centres and we will be asking for this amount," he told The Hindu.

When it achieves the mission, India would be the fourth nation to circle Earth after the Soviets, the Americans and the Chinese. In 1984, India's first astronaut Wing Commander (retd.) Rakesh Sharma orbited Earth as part of a Soviet mission.

Moving from watches to space

Change is inevitable with the passage of time, and this homily hits closer home for residents of Tumakuru as the city is all set to say goodbye to the factory of HMT Watches Ltd. and, in its stead, welcome the Indian Space Research Organisation (ISRO).

The 110-acre plot of land belonging to the defunct factory, which was closed on April 30, 2016, will be handed over to ISRO.

"The land of HMT was registered in the name of ISRO 15 days ago. We are organising a programme to formally hand over the HMT land to ISRO ," said Member of Parliament, S.P. Muddahanume Gowda.

Former employees of the defunct unit will participate in the ceremony.

With a workforce of 326, the factory — set up around 40 years ago — was the last of HMT's functional watch-making units to down its shutters.

It had the capacity to produce more than 20,000 watches a month, but by 2016, it was producing only 4,000.

According to officials, between 1978 and 2014, it had produced a total of 3.95 crore watches, worth Rs. 1,353 crore. However, at the time of closing, it was taking only institutional orders.

Mr. Muddahanume Gowda acknowledged the factory's contribution to the economic, social and educational development of Tumakuru district in its heydays. "Hence, on this occasion, we will express our gratitude to HMT, and also to the late former MP K. Lakkappa who was responsible for bringing HMT to Tumakuru 40 years ago," he said.

He expressed optimism on the potential of ISRO to pick up where HMT left off. "ISRO will help to create more than 4,000 jobs. It will help in the overall growth of Tumakuru district," the MP added

, Deputy Chief Minister Dr. G. Parameshwara will inaugurate the program, which will be attended by ministers S.R. Srinivas and Venkataramanappa, senior IAS officer in the Department of Space S. Kumaraswamy and senior HMT officials.

These beautiful strangers now thrive in India

These 'aliens' are here to stay. As many as 471 plant species that are alien or exotic — not native to India — are 'naturalised,' for they can thrive in the country's wildernesses by forming stable populations, says a recent report.

This list of naturalised exotic or alien species, ranging from the common guava (Psidium guajava) to prolific invasives such as lantana (Lantana camara), has been compiled in a recent study published in Biological Invasions , an international journal dedicated to the patterns and processes by which organisms invade ecosystems they are not usually found in.

Ecosystem altered

Naturalised species reproduce naturally in the environments they colonise. Invasive species do this so prolifically that they alter the workings of the natural ecosystems they colonise or invade. Lantana, for instance, replaces undergrowth and prevents native undershrubs and plants from surviving.

An international team—including scientists from the University of Delhi's Centre for Environmental Management of Degraded Ecosystems (CEMDE), the Botanical Survey of India (BSI) in Kolkata, Uttarakhand's Central Himalaya Environment Association and Andhra Pradesh's Sri Krishnadevaraya University—collated information on alien plant species from several sources, ranging from online plant lists to old compilations of India's national and regional flora.

Tamil Nadu leads

The team also developed the first lists of naturalised plants for each State; these lists reveal that 110 alien plants now naturally occur in more than 31 States in India. At 332, Tamil Nadu has the highest number of naturalised exotics, followed by Kerala (290), while Lakshadweep has the least (17).

The distribution across Indian States of over 20 of these naturalised species (in the list of 471) is unknown.

A majority of these naturalised plants are herbs such as the invasive Siam weedChromolaena odorata, native to south and Central America.

Pushing bats off their holy roosts

It is not just thousand-year-old deities that dwell in the ancient temples of southern Tamil Nadu. Bats too make their home in the little nooks and high ceilings that these stone structures offer. However, temple renovations could be lowering bat numbers in these sacred spaces, suggests a preliminary, yet-to-be-published survey.

The sight of bats inside some temples in Tirunelveli district piqued the interest of T. Ganesh (Senior Fellow, Ashoka Trust for Research in Ecology and the Environment; ATREE) and his students. How many bat species dwell in these temples and what makes them suitable bat homes?

The team, which began studying these bats since 2011, visited 22 temples across three towns (Kallidaikurichi, Ambasamudram, Alwarkurichi) in May 2018. They found 37 bat roost sites of seven species (including the Leschenault's rousetteRousettus leschenaultii and the Lesser mouse-tailed bat Rhinopoma hardwickii) in 18 temples. They also noted temperature, humidity, light and noise at these roost sites; basic analyses show that higher roost height and a combination of both noise and low light played a crucial role in bats selecting specific roost sites.

The team also noticed that temple authorities used several methods to prevent the mammals from roosting: they blocked bat entrances using nets and logs, filled up existing cracks, added lights, reconstructed temple towers and painted the old dark stones white. Six temples implemented some of these renovations in the later half of 2014.

Dropping numbers

The numbers of Schneider's leaf-nosed bat (Hipposideros speoris) dropped from 211 in May 2014 to 26 this year. However, a more detailed and robust study would be required to understand this better, says Chetan Misher, one of the research students at ATREE who conducted the study.

Temple renovation is indeed a main cause of disturbance to bats, according to D. Paramanantha Swami Doss (assistant professor at St. John's College, Payalamkottai), whose team has also been studying these temple bats for the last 15 years. Bat diversity could also be decreasing here, he adds.

"We recorded a [member of] Tadarida species [free-tailed bats] for the first time in Tirunelveli district from the Brahmadesam temple, but when I went there a few days ago, there were none left," he added.

While Dr. Doss hopes to focus on bat awareness sessions for local residents, Dr. Ganesh and his team hope to provide bat houses outside temples that the bats could use if renovations drive them out of their holy roosts.

Dire times for coastal fisheries?

The fishing industry along a portion of India's east coast could be on the brink of a collapse. This dire warning comes as scientists find that fisheries in coastal Tamil Nadu and Puducherry use destructive methods and do not

comply with existing regulations, which could stress the already over-exploited fish resources here.

Regulations are crucial in India, the world's second largest fish producer, where large scale motorisation of traditional fishing crafts began since the 1950s. Different categories of crafts – traditional catamarans, fibre glass boats, trawlers – have specifications, from the fishing gear they should employ to the distance they should head out into the sea. But are these rules followed?

GPS data

To generate baseline information on who fishes where in the sea, scientists from the Foundation for Ecological Research, Advocacy and Learning mapped and quantified fish catch, fishing gear, craft and crew details along 120 kilometres of the coasts of Puducherry, Villupuram and Cuddalore districts of Tamil Nadu. They attached global positioning systems to vessels; these, as well as field teams gathered information of over 3,427 fishing trips over 7,945 square kilometres of fishing grounds between June 2012 and June 2013. Their results, published in PLOS ONE on July 11 this year, reveal that there are distinct high-pressure fishing zones and overlapping fishing territories between traditional, motorised and mechanised crafts. Violations of the Marine Fisheries Regulations Act (including not adhering to fishing limits and using illegal fishing gear) are also frequent. The team also presented these results to the fishing community leaders of each village.

“We wanted to initiate discussions among the fishing communities regarding their role in fisheries management, for they adhere to decisions made by their community leaders,” said Tara Lawrence, lead author of the study.

Some of the recommendations made by these communities are listed in the study – such as suggesting that boats stick to their nautical mile limits – and can be achieved with enforcement and could potentially help the marine ecosystem recover, she adds.

According to marine biologist Divya Karnad who was not involved in this study, this work is a critical contribution to the study of small-scale fisheries in India. However, the data is a bit dated; since fisheries are ever-changing, comparisons with the present could offer better insight into change and adaptation in these fisheries, she wrote in an email.

“We need many more such systematic studies that collect long-term data,” she added.

Actual problems are solved only by 'whole men'

"If you have ever had a medical procedure, chances are you are benefited from the arts. The stethoscope was invented by a French flautist–physician named Rene Laennec who recorded his first observations of heart sounds in musical notation". Thus, begins an article by the physiologist Dr Robert Root-Bernstein in the July 6, 2018 issue of Science. He discusses how incorporating the humanities, arts, craft and design into curricula makes better scientists. He points to the recent report released by the Board on Higher Education and Workforce of the US National Academies of Sciences, Engineering and Medicine (NASEM), which has recommended that humanities, arts, crafts, and design (HACD) be integrated with science, technology, engineering, mathematics and medicine (STEMM). Dr Root-Bernstein quotes the developmental biologist Conrad Waddington, who said: "The acute problems of the world can be solved only by whole men, not by people who refuse to be, publicly, anything more than a technologist or a scientist or an artist"; and Professor Charles West, President of the US National Academy of Engineering, who says: "Engineering systems cannot be wisely envisioned, designed or deployed without an understanding of society, culture, politics, economics, and communications - in other words, the very stuff of the liberal arts and also of the social sciences".

India's graduates

India produces over 1.5 million engineering graduates every year, from 3,345 colleges and institutes. Sadly, a major portion of these graduates are not employable. As Ms. Maria Thomas wrote in the Economic Times last year, the rapid growth of India's IT industry during the last three decades had led thousands of students, often pushed by their parents, to pursue a profession that often guaranteed wealth, status - and with same luck, a one way ticket out of the country. Likewise India produces 52,000 doctors (MBBS degree) every year from about 1,700 medical colleges. Over 6.3 lakh students take the pre-medical entrance tasks, and a significant number among them manage to get into private colleges, paying hefty sums. Here again, it is the parental push for better future for their children. The quality of most doctors, particularly in small towns and rural areas is well known. Most of them are ignoramuses when it comes to HACD. These are not what Dr Waddington termed as "whole men".

The deficiency

Where does the deficiency lie? Right at the school level. Over the last seven decades, governments - both central and state - have abused the school system by fiddling around with the curricula, depriving schools of much

needed money, appointing ill-qualified teachers through quota systems (many of them not bothering to come to schools), playing with the syllabus and myriad other modes of interference. Education analysts such as Pratham have shown that the government school system is so bad that an eighth class student cannot solve a fifth class problem, and a fifth class student is unable to answer a third class question. People have preferred sending their children to private schools, and these are money-making machines, not easily affordable by the lower middle class families. This, combined with the need for steady jobs and income for the child once he/she graduates, has played havoc with our education system, Thus were born coaching centres, run by the politically connected, which take students right at the secondary school level and send them through tortuous courses so that they may pass engineering and medical entrance examinations. And in none of these coach centres, nor in the schools, are students taught HCAD at any level, and those who successfully come out of these mechanised teaching factories are absorbed in the NITs, IITs or medical colleges, but with no 'soft skills'. It is high time that the school system is revamped and HACD introduced from the very beginning.

It is with this deficiency in mind that the IITs, BITS Pilani, Manipal Academy of Higher Education, and a few others, have tried to make up through the introduction of 'core courses' in the first few semesters, where the students are taught language, literature, humanities and social sciences, arts and crafts, and design. Happily enough, several IITs now have actual departments in some of these subjects (besides technology and science departments) where faculty members teach and also do research in areas of HACD. (One beautiful example of this was the design of the convocation robes designed at the IIT Hyderabad last week, using Ikat stoles made by local weavers). These core courses at IITs and BITS are of some help. Similarly Christian Medical College at Vellore requires their graduating doctors to spend a year in rural India. Working in villages gives the young scholar a perspective of the community, its needs and its talents and enriches the mind. And professional IT companies offer months-long sessions to their trainees in generic and stream learning plus "soft skills". What about the other technological and medical institutions?

Route to eminence

Sadly, the Central Ministry of Higher Education does not appreciate the value of liberal arts and HCAD. A glaring display of this has been the identification of four institutions of technology, and one "green field" institute yet to be made, as Institutions of Eminence. Tellingly, not one university or institute devoted to HACD was thought of as eminent! What

the government decides is eminent is at variance with what the professional scholars think.

Given this disconnect, here is one suggestion: why should some of these 'green field' institutes not concentrate on HCAD rather than more technology-based ones? Better yet, rather than start institutes, establish Trusts that catalyse and promotes HCAD?

Paleo-rivers predated Harappans by 35,000 years

A recent study on direct dating of sediments extracted from paleochannels close to Harappan sites in the region of Sutlej-Yamuna interfluve by a team of scientists from the Physical Research Laboratory, Ahmedabad (PRL) and CNRS, France, indicate that these rivers changed their course nearly 35,000 years before the Harappans came to settle there.

Scientific evidence

Along with a 2017 paper in Nature Communications by A. Singh from IIT Kanpur and others, this study now provides scientific evidence that contradicts the suggestions on Harappans flourishing on the banks of the mythical Vedic rivers, Sarasvati and Drishadvati. These studies provide evidence that these rivers changed their course much before the time of Harappan settlements about 5,000 years ago. The study was published recently in Quaternary Geochronology.

The discovery of several hundred Harappan sites in the Sutlej–Yamuna interfluves led archaeologists to infer that like other ancient civilisations, Harappans too flourished on the banks of mighty rivers. Presence of ephemeral rivers Ghaggar-Hakra and Chautang in this area led people to suggest that these were vestiges of the once mighty glacial rivers on whose banks the Harappan civilisation was established. This gained popularity when a paleo-channel (ancient remains of rivers) was discovered in this region.

The naming of a paleo-channel and associating it with archaeological sites irked the curiosity of Prof. A.K. Singhvi from PRL. "To me this appeared unrealistic and far-fetched. A ballpark analysis of Harappan site per unit time indicated that the numbers of settlements to be supported [by a large river] were too few and the need to invoke a mighty river was somewhat misplaced," he says.

For over three decades many papers were written but this premise was not tested scientifically using modern dating techniques till now.

Settlement patterns

This study analysed the distribution of Harappan sites along the two main rivers in the region – the Indus, which is perennial, and the Ghaggar-Hakra, which is ephemeral; examined the mineralogy of river sediments to establish their source and dated the entire sediment succession of the region using dating technique to establish the event chronology of the evolution of the region.

The authors conclude thus: "Settlement patterns and other analysis suggest that factors other than perennial rivers dictated their [Harappan's] settlement" and that, "Major change in the river dynamics occurred between 24,000-45,000 years ago (most likely around 40,000-45,000 years ago), and for 25,000 years the landscape has not changed significantly."

Prof Singhvi, who led the study, states that ipso-facto this study implies that so called paleo-river features are far too old to be associated with Vedic times.

"Care should be taken in making a linear association of river hydrology with abundance of archeological sites," he says.

He points out that this inference is also buttressed by the evidences of water harvesting techniques of Harappans, the cropping patterns suggesting their dependence on seasonal monsoon rather than constant supply of water.

Gecko species split in three

Termite hill geckos are all chocolate-brown, banded and small enough to fit into your palm. But the finer physical details and genetic differences reveal that what was believed to be one species is now three: the Whitaker's, Sahgal's and southern termite hill geckos.

In the past, scientists depended solely on physical differences to describe new species. Now, researchers can use genetic techniques to identify a new species. Many researchers also use a combination of these to tap into the strengths of both methods and obtain more robust results.

This is precisely what Zeeshan Mirza, of Bengaluru's National Centre for Biological Sciences (NCBS), and his colleagues did when they suspected that there could be "hidden" species amongst termite hill geckos (lizards which are widely distributed across India, Sri Lanka and Pakistan; their taxonomy has been confusing in the past).

The team collected termite hill geckos across Maharashtra, Karnataka, Andhra Pradesh, and Gujarat, Tamil Nadu and Pondicherry and extracted genetic data from these samples.

The four genes they studied reveal that all these geckos separated neatly (and robustly) into three different 'clades' or branches.

Herpetologist honoured

Samples from Nellore, Pondicherry and Sri Lanka (recognised as a sub-species till now) grouped as one, proving that they were one species; the team designated this as the southern termite hill gecko (Hemidactylus triedrus).Samples from south Karnataka and the Nilgiris district in Tamil Nadu formed a separate clade, distinct enough to be a separate species; the researchers named it Hemidactylus whitakeri (in honour of herpetologist Romulus Whitaker's contributions to the conservation of India's reptiles). Geckos from Maharashtra, Gujarat and parts of Pakistan clustered together and Mirza and colleagues have named it Hemidactylus sahgali, after Bittu Sahgal, the editor and founder ofSanctuary Asia magazine.

Physical features

Detailed examinations of the physical features of the geckos from existing literature and by comparing both the newly collected specimens and museum specimens also complemented the genetic descriptions. Small pores on its thigh demarcate the Sahgal's gecko clearly from the other two; however, identifying and comparing many of these features on field takes a trained eye.

According to Mirza, lead author of the study published in PeerJ, using numerous methods together has helped solve the taxonomy of a species that has been debated for two centuries and also reveals that we do not know enough about the distribution of the Whitaker's and southern termite hill geckos.

"More studies in India's arid habitats could reveal more 'hidden' species," he adds.

Green process cuts water use, pollution in textile industry

A completely green method developed by researchers from the University of Calicut, Kerala, can potentially do away with using water for sizing and desizing cotton and polyster yarn. Textile industry is highly water-intensive and also one of the biggest water polluters.

By using liquid and supercritical carbon dioxide instead of water, and sucrose octaacetate in place of starch, team of researchers led by Dr. Poovathinthodiyil Raveendran from the University's Department of

Chemistry has made the sizing and desizing process eco-friendly. The results of the study were published in the journal ACS Sustainable Chemistry & Engineering.

Before the yarn is woven into fabric, it is coated with sizing agents to strengthen the yarn (to decrease breakages on the loom) and protect it from damage and reduce friction. Sizing also removes or smoothens the projecting microfibres that might interfere with the weaving process.

Traditionally, starch mixed in water is used for the sizing process, and this requires plenty of water. The used water is disposed of, leading to water pollution. "So we looked at changing the sizing process from a wet to a completely dry process," says Dr. Raveendran. The researchers used liquid carbon dioxide as solvent and tested three agents that easily dissolve in carbon dioxide for sizing both cotton and polyester yarn.

Best agent

"Of the three agents tested, we found sucrose octaacetate produced the best results," says Dr. Raveendran. The yarn had a smooth, glassy coating on the surface and the strength of the yarn (cotton and polyester) nearly doubled and the yarn exhibited improved mechanical properties essential for weaving. All the microfibres that protrude from the yarn were aligned and smoothened. The abrasion resistance also increased upon sizing.

The yarn after sizing has to be dried when water is used, making the entire process energy-intensive. But no drying is needed when liquid carbon dioxide is used as it is an inherently dry process. When the pressure of carbon dioxide is reduced to gas phase pressure, the carbon dioxide changes its state from a liquid to gas leaving the yarn dry. "The yarn becomes dry instantaneously," he says.

Once the weaving is completed, the sizing agent has to be completely removed from the yarn as it might resist dyes and chemicals commonly used in textile processing. In the conventional desizing process, large volume of water is used for desizing or washing the fabric to remove the sizing agent from the yarn, which generates lots of waste water.

Instead of water, the researchers used supercritical carbon dioxide for desizing. "While both liquid and supercritical carbon dioxide have lower viscosity and surface tension compared with water, the molecular diffusion of supercritical carbon dioxide is 10 times more than liquid carbon dioxide," says Dr. Raveendran. "The more the molecular diffusion, the faster will be the movement of molecules in the fluid and this determines the efficiency of

cleaning." The sizing agent dissolves in the supercritical carbon dioxide when it comes in contact with it.

As in the case of sizing, the yarn (in the fabric) becomes dry almost instantaneously when the pressure of carbon dioxide is reduced to gas phase pressure after desizing. And the sizing agent separates out from the yarn and settles at the bottom.

"The best part of this process is that it is zero-pollution, zero-waste as both carbon dioxide and the sizing agent (sucrose octaacetate), which is modified cane sugar, can be recycled endlessly," says Dr. Raveendran. The researchers are next planning to scale up the process and are looking at setting up a pilot plant to test the green process.

Sea food waste prevents steel corrosion

Mild steel used in a wide range of industries easily develops rust and the corrosion causes huge economic loss every year. As chemical corrosion inhibitors are detrimental to the environment, there is an urgent need to develop green inhibitors. Now, researchers from Indian Institute of Technology (BHU), Varanasi, have successfully produced a chitosan-based corrosion inhibitor that shows over 90% efficiency.

Chitosan

Chitosan is a natural polysaccharide found in the shell of crab, shrimp and also in the cell wall of fungi. "As the solubility of chitosan in water is poor, polyethylene glycol (PEG) was incorporated to it and a novel PEG-crosslinked chitosan was developed. PEG is non-toxic and has been approved by the FDA even for internal consumption," says Vandana Srivastava from the Department of Chemistry of the institute and first author of the paper published in Chemistry Select.

Mild steel was immersed in a corrosion-inducing solution of hydrochloric acid containing different concentration of chitosan-PEG ranging from 50-200 mg/L for six hours. The novel inhibitor was found to form a thin film on the metal surface.

"We studied the precise chemical mechanisms and found that the inhibitor is adsorbed as a thin film on the steel surface. The inhibitor blocks the active sites on steel available for corrosion thereby mitigating corrosion," explains M.A. Quraishi from the institute and corresponding author of the work.

Weight loss studies and electron microscopy imaging showed that a maximum inhibition of 93.9% was achieved when the concentration of the treated solution was 200 mg/L.

Smooth surface

"Usually when steel is treated with anti-corrosive agents there is a change in its surface and it tends to get rough. But our inhibitor did not alter the surface. In fact, there was a significant improvement in the surface smoothness," Prof. Quraishi adds. "The shells of the shrimps are usually discarded as waste and if we can use them and develop such eco-friendly products it will be a good way to convert waste material to a useful application."

Mutant worms live 60% longer on specific diet

From an average of about 18 days in the lab, the longevity of C. elegans, the popular model organism for ageing research, increased 40–60% when researchers used a mutant that lacked the function of a particular gene (flr-4) and fed them a specific bacterial diet — E. coli strain H. The mutant worms fed another bacterial diet — E. coli strain O — did not show any increase in life span. Scientists use the term "diet-gene pairing" to describe such events.

So far, only four gene-diet pairs that modulate longevity have been discovered using these worms. And researchers from the National Institute of Immunology (NII), New Delhi led by Arnab Mukhopadhyay have discovered the fifth such pair. The results were published in the journal PLOS Genetics.

That longevity increases with reduced caloric or dietary restriction is well known. But in this study, there was increase in life span of the mutants even when there was no restriction on the quantity of food consumed. To find out the relation of flr-4 gene and dietary restriction, the researchers generated a condition where the mutant worms had reduced food intake.

One would expect the dietary restriction in the mutants to cause an additive effect leading to further increase in life span. "But we did not see an additive effect. So the cellular module or mechanism by which food restriction increases lifespan overlaps with the mechanism by which flr-4 mutation increases longevity. This shows that organisms have evolved distinct as well as overlapping ways to evaluate both the quality and quantity of diet to regulate lifespan," says Dr. Mukhopadhyay.

"The study shows a specific interaction between a gene and a particular diet. This tells us how we are interacting closely with food at the molecular level,"

he says. “Since such gene-diet pairings that regulate life span are not yet characterised in mammals, we are using a simple model organism to find out specific nutrients and genes which together will increase longevity.”

The understanding of gene-diet pairings is important as it will give researchers a handle to engage a targeted approach to regulate lifespan. Though it is currently at a very nascent stage, it might become possible some day in the future to increase the lifespan of humans by changing a gene-diet interaction.

Mechanism of action

The researchers found that when the mutant worms lacking the flr-4 gene feed on H strain of E. coli bacteria, but not the O strain, the p38 MAPK pathway gets activated. This activated pathway then increases the expression of cyto-protective XDP genes, leading to enhanced protection of the cells from age-induced damages, thereby increasing the lifespan.

To validate the role of the p38 pathway and XDP gene in cell protection leading to increased lifespan, the researchers suppressed their activity in the mutant worms. The lifespan of the mutants was reduced and became comparable with normal worms.

“We are currently studying whether it is micronutrients, vitamins, fat or carbohydrate produced by the E. coli that is being sensed by the pathway leading to increased longevity,” says Dr. Mukhopadhyay.

The flr-4 gene is present only in specific tissues, such as neurons and gut. “The lifespan was more [40-60%] when the gene was knocked out [removed] from the entire body than from the intestine or the neurons alone,” says Sonia Verma from NII and first author of the paper. “We have not been able to knockout the gene from both the intestine and the neurons at the same time. So, can’t say if there will be an additive effect. But the indications are that these two tissues independently contribute to life span.”

Centre launches portal for scientific research, funding

How does a budding math enthusiast figure out career prospects for pursuing mathematics in India? Which individual professors are blazing new trails in, say, climate change research here?

The Union science ministry’s communication wing, Vigyan Prasar, has launched the India Science Technology and Innovation portal that can help with such queries.

Currently the portal can be queried for information about the organisations carrying out research, those funding them, international collaborations, the scientists involved in the research, the states in which they are being carried out, their achievements and impact.

Prime focus

There's also a compilation of technologies developed in India, the organisations that have developed these technologies, those that have funded them and the status of the technologies. "A major thrust of the portal is to reach out to students, researchers, scholars, scientists both from India and abroad, so that they can choose from the mine of fellowships, scholarships and funding and startup opportunities that India puts on their plate," says a note accompanying the portal.

The portal follows a launch this week of India Science (indiascience.in), an Internet-based science channel, to showcase the developments in science and technology in India.

Both the portal and the channel are part of a push by the Science Ministry to improve its public outreach. By next year, the Ministry hopes to offer science programmes on Doordarshan and eventually launch a dedicated science channel.

According to a roadmap prepared by the Union government, the Science Ministry proposes to spend Rs. 15 crores over five years to cover costs of portal development and updates.

JNCASR: A new, robust form of gold

Researchers from Jawaharlal Nehru Centre for Advanced Scientific Research (JNCASR), Bengaluru, have developed a new type of gold in the form of very small crystals — microcystallites. The microcrystal gold has been found to be nobler than gold — it do not dissolve in mercury and Aqua regia (a mixture of nitric acid and hydrochloric acid), and showed the least interaction with copper.

The microcystallites were synthesised by decomposing an organic complex containing gold and other ions under controlled conditions. The newly formed microcystallites, about 3 micrometre in length were found to be of a different crystal structure. Normal gold has a (face-centered) cubic structure, while the new ones exhibit deformed cubic structure — tetragonal and orthorhombic cells.

Copper growth

The researchers then examined copper growth on these gold crystals when subjected to plating without the use of electrodes. Electron microscopy images revealed that thick copper got deposited on normal gold within minutes, while no detectable copper was seen on the central portion of the new crystals even after an hour. “We found deposition of copper only on the tips of the new crystallites while the rest of the crystal surface was devoid of copper. This may be due to the different arrangement of the new facets,” explains Chaitali Sow, Ph.D student at JNCASR and one of the authors of the paper published recently in Angewandte Chemie.

The researchers then investigated the stability of the gold microcystallites using corrosive agents like mercury and Aqua regia. While normal gold disappeared in a matter of minutes when immersed in mercury and also in aqua regia, the gold crystallites remained intact. Microscopy imaging showed that the surface was undamaged.

“All these properties make our new crystallites an ideal candidate for catalytic purposes. Gold in itself is not a catalyst but the new gold microcystallites have very active surfaces. Compared with other catalysts like palladium and ruthenium, gold is cheaper and it can also be easily recovered,” explains Prof. Giridhar U. Kulkarni, Director at the Centre for Nano and Soft Matter Sciences (CeNS), Bengaluru and corresponding author of the paper. “Though the production cost of the crystallites is a little high, we are optimising it to bring down the cost. More studies are needed to understand them fully in the context wide range of applications in the offing,” he added.