

VIGYAN PRASAR

DREAM

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I AM NOT A
WICKED
CREATURE

KNOW YOUR
MEDICINE:
PARACETAMOL

HOT AIR BALLOON:
THEN AND NOW

BHARAT RATNA MOKSHAGUNDAM VISVESVARAYA

A LEGENDARY NATION BUILDER

Editor-in-Chief:

Nakul Parashar

Editor:

Nimish Kapoor

Production:Pradeep Kumar
Bipro Kumar Sen
Amitesh Banerjee**Expert member:**Biman Basu
Sumita Mukherjee**Address for
correspondence:**Vigyan Prasar, A-50,
Institutional Area, Sector-62,
Noida-201 309, U.P., India**Tel:** +91-120-2404430, 35**Fax:** +91-120-2404437**e-mail:**

dream@vigyanprasar.gov.in

website:<http://www.vigyanprasar.gov.in>

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Telefax: 22424396, 22526936.

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MY WORD

NAKUL PARASHAR

Catch them Young

"CATCH

them young", is an interesting axiom. It conveys the aspiration to coach, serve, aid and associate a youngster early in his or her age to grow a passion for learning in order to become a long-lasting mentee. If this expression is applied to STEM, we could build researchers at a very young age. The quest that exists in every young mind, if channelised through meaningful and most attractive means and methods, the number of children opting for science would enhance manifold. There are a number of ways to do it. Creating competitive events, creating more and more visual aids in language that kids can easily understand, and allowing them to learn things through both hands-on and minds-on activities are some of the popular ways that can be adopted to develop research minds at a very young age. Olympiads, for that matter, have been quite successful as they create channels for competitiveness. Vidarthi Vigyan Manthan, popularly known as VVM, is a joint venture of Vijnana Bharti and Vigyan Prasar. The competition commences from a classroom and moves up all the way to the national level via district and state-level stages. In its third year of existence now, growing numbers of participants speak volumes about VVM's growing popularity. This way, VVM's objective to catch-them-young gets proven too. Incidentally, the fourth version of VVM has been recently launched, and registrations are open.

Besides VVM, there's yet another interesting set of 30 hour-long lecture series on STEM by the Centre of Creative Learning at IIT Gandhi Nagar in Gujarat. This lecture series is in line with NEP 2020 (New Education Policy 2020) that CBSE has launched as

3030 STEM. This is an online program focussing on basic conceptual understanding and critical thinking of Math/Science. The aim of the program is to unlock the hidden mysteries, beauty and magic of Science/Math that is all around us. I have heard and seen a part of the valuable repository that CCL at IIT Gandhinagar has, and the passion with which Dr Manish Jain, the main facilitator of the program steers the lectures is indeed worth an experience. By the way, all of these 3030 STEM lectures are available on India's own S&T OTT Channel, IndiaScience. in as well.

Meanwhile, on the pandemic end, the race against time to produce a vaccine against COVID-19 is on. As we write, a number of efforts have entered phase III of human trial stage, which according to scientists indicates a quantum leap towards the finishing line. On the whole, out of 160 reported vaccine candidates in research-action, one-third of them have reached clinical trial stage. In India, two out of eight are stepping into phase-II trials. The world anxiously awaits the good news, as definition of living with the new normal keeps changing with every passing day.

In this issue of Dream 2047, we bring to you detailed account on Bharat Ratna Mokshagundam Visvesvaraya. His birthday is celebrated as the National Engineer's Day every year on 15 September. This year we shall celebrate his 160th birth anniversary. Our birthday wishes to the legend, who kept on working actively till the age of ninety.

Stay safe, stay happy!

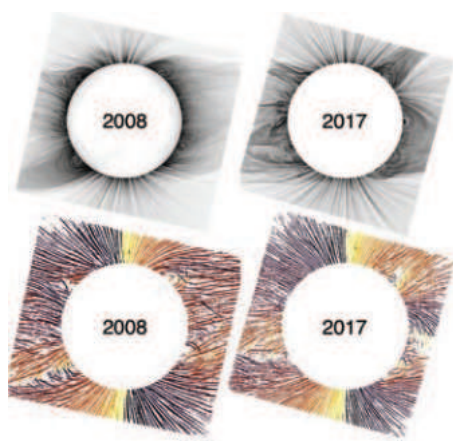
Email: nakul.parashar@vigyanprasar.gov.in

RECENT DEVELOPMENTS IN SCIENCE AND TECHNOLOGY

ASTRONOMERS UNVEIL
THE MAGNETIC FIELD OF
THE SOLAR CORONA

The Sun's corona is the outermost part of the Sun's atmosphere, which expands into interplanetary space. The solar corona is so faint that it is visible only during a total solar eclipse when the bright solar disc is completely blocked by the Moon. The corona releases streams of energised, charged particles, primarily electrons and protons, flowing outward which is called the solar wind. The solar wind, mostly made of plasma, travels through the solar system at speeds as high as 900 km/s and a temperature of 1 million degrees Celsius.

According to astronomers, the properties of the solar corona arise from the Sun's complex magnetic field, which is produced in the solar interior



The top panels show the visible light (colour inverted), while the lower panels show the magnetic field shape. Fine details, quantified for the first time, are visible throughout the corona. (Credit: B. Boe/IfA)

and extends outward. Graduate student Benjamin Boe at the University of Hawaii Institute for Astronomy (IfA) have now succeeded in measuring the shape of the coronal magnetic field with higher spatial resolution by using data of total solar eclipse observations spanning more than

20 years (The Astrophysical Journal, 3 June 2020 | DOI: 10.3847/1538-4357/ab8ae6).

Boe says, "The corona has been observed with total solar eclipses for well over a century, but never before had eclipse images been used to quantify its magnetic field structure." For this study, Boe traced the pattern of the distribution of magnetic field lines in the corona, using an automatic tracing method applied to images of the corona taken during 14 eclipses across the past two decades. This data provided the chance to study the changes in the corona over two 11-year magnetic cycles of the Sun.

According to Boe, during periods of minimum solar activity, the corona's field emanated almost straight out of the Sun near the equator and poles, while it came out at a variety of angles at mid-latitudes. During the solar activity maximum, on the other hand, the coronal magnetic field was far less organised and more radial.

QUARK MATTER PRESENT
IN NEUTRON STARS

Neutron stars are the end products of giant stars that die in fiery explosions known as supernovas. The almost incomprehensible density of a neutron star causes protons and electrons to squeeze together and combine into neutrons—the process that gives such stars their name. While the first observation of a neutron star dates back all the way to 1967, accurate mass measurements of these stars have only been possible for the past 20 years or so. However, till recently, not much was known about the internal structure of neutron stars. Now, an international

team of researchers has found strong evidence for the presence of exotic 'quark matter' inside the cores of the largest neutron stars in existence. Quark matter is a state of matter which may exist at extremely high temperatures and densities, composed of quarks and gluons moving freely and not bound together within hadrons. It is an extremely dense phase of matter that may exist at the heart of neutron stars. It can also be created for brief moments in particle colliders on Earth, such as CERN's Large Hadron Collider.

According to the new study, matter residing inside the cores of the most massive stable neutron stars bears a much closer resemblance to quark matter than to ordinary nuclear matter

(Nature Physics, 1 June 2020 | DOI: 10.1038/s41567-020-0914-9).

Aleksi Kurkela from CERN's Theory department and the University of Stavanger, Norway and colleagues used a neutron-star property deduced from the first observation in 2015 by the LIGO and Virgo scientific collaborations of gravitational waves—ripples in the fabric of spacetime—emitted by the merger of two neutron stars.

According to the researchers, it is precisely this rapid accumulation of new observational information that played a key role in improving the accuracy of the new findings and in confirming the existence of quark matter inside neutron stars.

Continued to page 18 →

Dr Harsh Vardhan announces successful completion of first pan-India 1000 genome sequencing of SARS-CoV-2

On August 1, 2020, Dr Harsh Vardhan, Minister for Science & Technology, Health & Family Welfare and Earth Sciences announced the successful completion of PAN-India 1000 Genome sequencing of SARS-CoV-2. In a meeting with Department of Biotechnology (DBT) he reviewed the COVID-19 activities of DBT, Biotechnology Industry Research Assistance Council (BIRAC) and DBT-Autonomous Institutions (AIs).



During the meeting, Dr Harsh Vardhan also launched and dedicated to the nation the largest network of five dedicated COVID-19 Biorepositories established by Department of Biotechnology in record time. These are at THSTI, Faridabad; ILS, Bhubaneswar; ILBS, New Delhi; NCCS, Pune; and InStem, Bangalore. He complemented the efforts of DBT in “the relentless war for mitigation of this Pandemic”.

Dr Harsh Vardhan said, “Given the importance of this information for public health response initiatives requiring investigation into the transmission of COVID-19, the sequence data will soon be released in Global Initiative on Sharing All Influenza Data (GISAID) for use by researchers across the Globe.” Dr Harsh Vardhan also highlighted that “16 Vaccine Candidates are in different stages of development. The BCG Vaccine is undergoing phase 3 trial, Zydus Cadila DNA Vaccine is in phase I / II trial and 4 Vaccine candidates are in advanced stages of pre-clinical study.”

Launch of compendium on CSIR technologies for COVID-19 mitigation

CSIR and its constituent laboratories have been working continuously to fight COVID-19 and have introduced a number of technical solutions against the pandemic. Now a compendium of such technologies prepared by the CSIR has been launched by Hon’ble Minister for S&T, Health & family welfare and MoES Dr Harsh Vardhan recently in New Delhi.

The compendium covers a wide range of technologies and products spanning from diagnostics to drugs to ventilators and PPEs with more than 100 technologies, 93 industry partners listed and with over 60 of these technologies have been transferred to industry.

Dr Harsh Vardhan observed that “The portfolio of technologies and products developed in a short time are a testament to the capabilities of CSIR scientists and that they can deliver in most difficult of the circumstances.”



DG CSIR, Dr Shekhar C Mande said that CSIR has partnered with not only large industries such as TATA Sons, Reliance Industries etc. but also with PSUs such as BHEL and BEL and MSMEs for the deployment of the technologies and products at the earliest. Further, he highlighted that CSIR has developed a COVID-19 Portal that captures these technologies in an easily searchable format for users.

JNCASR scientists devise adaptive model to estimate, strategize critical resources in pandemic

Healthcare in a country faces a catch-22 situation in the early stages of an epidemic—specific and accurate tests are required to trace and isolate the infected, and to scale up the novel tests, one

needs to have estimates of the expected number of infections weeks to months in advance. And then, these numbers need to be used to predict healthcare inventory requirements in every district of the nation. How does one use models for these estimates when the inputs to the models could be rampant with uncertain parameters?

Scientists from Jawaharlal Nehru Centre for Advanced Scientific Research (JNCASR), and Indian Institute of Science (IISc) have developed a model to address this problem using an adaptive strategy and the early phase of COVID-19 as an example.

The model can be utilized to estimate key aspects of medical inventory requirements. It would be extremely relevant for COVID-19 as the disease character and the behavioural patterns of the people change and affect the efficacies of disease spread and management in a second-wave, requiring constant alertness on the part of the forecasters.

DBT-supported COVID-19 vaccine begins adaptive phase I/II clinical trials

Phase I/II clinical trials on a plasmid DNA vaccine designed and developed by Zydus and supported under DBT’s National Biopharma Mission has been recently initiated in healthy subjects, making it the first indigenously developed vaccine for COVID-19 to be administered in humans in India.

The multi-centric adaptive Phase I/II dose escalation study will assess the safety, tolerability, and immunogenicity of the vaccine. Named ‘ZyCoV-D’, the vaccine was found to elicit a strong immune response in the pre-clinical phase in multiple animal species like mice, rats, guinea pigs and rabbits. The antibodies produced were able to neutralize the wild type virus in virus neutralization assay indicating its protective potential. No safety concerns were observed in repeat dose toxicology studies by both intramuscular and intradermal routes of administration.



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COVER STORY

MATIUR RAHMAN

— BHARAT RATNA MOKSHAGUNDAM VISVESVARAYA —



A LEGENDARY NATION BUILDER

T

he legendary nation builder, a staunch votary of technical education and industrialisation, Sir Mokshagundam Visvesvaraya, popularly known as Sir MV, was a noted civil engineer and an expert in irrigation design, reservoirs, dams, drinking water supply and drainage schemes.



The engineering contributions of Sir M. Visvesvaraya, especially in the building of the Krishnaraja Sagar (KRS) dam across the river Cauvery in Karnataka and turning around the fortunes of Mysore Iron Works and the Kolar Gold Fields in Pre-independent India are recognised the world over. The technique of construction of the KRS dam without using cement and smelting iron ore without the use of coal for producing pig iron at Mysore Iron & Steel Works are exemplary.

Even today, a number of locations in Karnataka stand testimony to his engineering skills at Bengaluru, Bhadravati, Shivanasamudram, the Kolar Gold Fields, and of course, the Krishnaraja Sagar Dam near Mysuru.

Even though it was a time when every little thing, from needles and nibs, tumblers and tea cups, buttons and biscuits, paper, pencils and pens, bicycles and toys were all either stamped 'Made in England' or 'Made in Germany' or 'Made in Japan', Sir M Visvesvaraya conceived and executed the largest reservoir in India and one of the largest of its kind in the world, about forty years before independence of India. The dam was later named as Krishnaraja Sagar Dam. For commoners, it defied imagination, but not for a man named Sir M. Visvesvaraya.

Towards the south-western direction of Bengaluru, about a hundred and fifty kilometres away, getting close to Mysuru and going further down into the Srirangapatna taluk of district Mandya, it is easy to see one of the largest known irrigation channels in India—the 45-km long Visvesvaraya Canal of the Krishnaraja Sagar Dam along with other canals originating from this dam. These canals irrigate over 1,25,000 acres (50,585 hectares) of land in Mandya, Malavalli, Nagamangla, Kunigal and Channapatna taluks apart from Ramnagaram and Kanakpura in Karnataka. Also generating power and supplying drinking water to the cities of Mysuru and Bengaluru, the Krishnaraja Sagar dam, popularly known as KRS, is a marvel of technology and state planning and one of the greatest achievements of Sir M. Visvesvaraya.

In his early career as a water resources engineer, Sir MV planned and designed water supply schemes for Kolhapur, Belgaum, Dharwar, Bijapur, Ahmedabad and Pune.

When the Public Works Department of Bombay Presidency was faced with a challenge in early 1900 to increase the storage capacity of Khadakvasla reservoir near Pune, without raising the height of the dam, Sir MV was the man they pinned their hopes on.

Similarly, in 1908 when Hyderabad was devastated by floods, Sir MV came

to the rescue of the Government of the Nizam of Hyderabad. Osmansagar and Himayatsagar dams were built on Sir MV's advice.

And sometime later, when the fourth Maharaja of Mysore was at a loss about keeping a promise he had made to the administration of the Kolar Gold Fields, he could not look any further than M. Visvesvaraya.

Sir MV was the man people looked to when in distress. Challenges thrown at Sir MV were countless and continuous — some administrative and a lot technical. His most celebrated work, the Krishnaraja Sagar dam had both in ample measure. The estimated cost of Rs. 253 lakh in the first decade of 1900 was an amount that the Mysore State had never spent on any single project. The scheme was opposed tooth and nail. Opponents were of the opinion that the role of a bureaucrat was that of an administrator, and not one of proposing innovative and creative development schemes. And here was Sir MV who was convinced about the social purpose of this large engineering project. And soon upon approval of the Maharaja, the village Kannambadi started seeing a lot of surveying and construction activities by the beginning of 1911.

No cement and yet the large multipurpose non-overflow gravity type 'Krishnaraja Sagar masonry dam' was built.

Three years after the KRS started getting built, World War I broke out. It did bother Sir M. Visvesvaraya a lot, but his bigger worry was about impounding the waters of the river Cauvery by taking recourse to modern aspects of hydraulic engineering, especially when the principles of building large masonry dams were not too well understood at that time.

The biggest challenge though, for Sir MV, was to build the dam without the use of cement. Cement manufacturing was still

in its nascent stage at that time in the country. It had to be imported at a high cost. In the absence of this ubiquitous binding material, the manner in which the engineers of yester-years built such huge civil structure as the KRS dam is reflective enough of the ingenuity of their technical skills.

They found that about twenty years earlier, in 1889 to be precise, some enterprising Indian engineers had developed a special kind of mortar which was as good as cement and they used it in the construction of the Van Vilas Sagar dam across river Vedvathi at a place called Marikanve in the Chitradurga district of today's Karnataka. They called it "Surkhi mortar". The technique was further perfected on the KRS dam.

MOKSHAGUNDAM VISVESVARAYA

- Civil engineer extraordinaire
- Master in irrigation design, reservoir and dams
- Chief Engineer of Mysore state 1909
- Dewan of Mysore State 1912-1918
- Staunch votary of technical education and industrialisation.



Sir MV's home (Photo: Poonam Chaurasia)

The mortar used for the masonry was specially prepared at the site. Burning natural hydraulic lime and mixing it with burnt broken bricks in the ratio of 1:4 and grinding the mixture to a paste produced the surkhi mortar. This special mortar was found to possess certain superior qualities over cement mortar. And one of them was its ability to not let the temperature rise as much as cement when it sets. And what is more, building with surkhi mortar did not produce any construction joints because rubble and stones got set in the mortar randomly before they hardened. And that is how the 'body' of the KRS dam was built.

KRISHNARAJA SAGAR DAM

Height: 134 ft

Width: 111 ft

Length: 2.5 km

Storage: 48,000 million cubic feet

Beginning in 1911, its construction progressed in stages.

Some of the significant milestones were

1911 Cauvery Basin Survey started.

1914

- Foundation laying in the River Bed over.
- North and South Banks completed.
- North Bank Canal excavated up to 48 miles.

1915

- Dam height reached 65 feet.

1919

- Dam height reached 107 feet.

1921

- First stage of the reservoir nearly completed.

1926

- Excavation of the High-level Canal.
- Water allowed for irrigation.

1928

- Dam height reached 130 feet.

1932-34

- Construction of KRS Dam completed.



Bird's eye view of the Krishnaraja Sagar dam. (Photo: Matiur Rahman)

Completed in 1934, the KRS was the very first big multipurpose dam on the river Cauvery. It was named after the fourth King of the princely state of Mysore, Maharaja Krishnaraja Jaya Chamrajendra Wodeyar, during whose rule Sir M. Visvesvaraya, as the Chief Engineer of Mysore designed and got the dam built. It was time for Cauvery to present several new faces of development not seen earlier. Apart from reaching deeper depths for mining, the KRS dam made many other activities possible. Mills and factories were now lit up, saw mills and threshing machines were livelier, crushing canes became faster, ginning cotton and extracting oil was less drudgery prone, water could be heated, and rice could be cooked by electrical power.

The most visible difference, however, was in the cultivation of sugarcane since this perennial crop required water throughout the year. The production jumped several fold. Sir MV, therefore, advised the Government of Mysore to establish a white sugar factory for utilising the large sugarcane produce. And that is how the Mysore Sugar Company came into being. Even today, the district of Mandya continues to be a leading producer of sugar. And because commercial crops like mulberry and other horticultural crops could be cultivated, the state started receiving increased revenue.

All the doubts over the KRS being a success were laid to rest. More so, because the supply of power to the Kolar Gold Fields had increased, a promise that the fourth Maharaja of Mysore had made to the administration of Kolar Gold Fields. Six long-distance electrical lines brought 78 kV electricity at a frequency of 25 Hz. to the receiving station at Kolar Gold Fields.

Flood control system

Apart from irrigation design, KRS is also unique for its flood control system. The distinctive roundish structures seen alongside the dam—the wells which work in conjunction with the automatic gates, are central to the unique flood control mechanism of the KRS dam. These special wells are noticed very easily. But what is normally hidden from the eyes are its automatic gates. Because they are installed under the dam, it takes a little effort and some risk too, to reach the place where the automatic flood gates, also called sluice gates are located.

The dam uses 171 gates of which 48 numbers of automatic sluice gates are the ones invented by Sir MV. All the 48 automatic gates are made of cast iron and



KRS Dam (Photo: Matiur Rahman)



were produced at Mysore Iron & Steel Works, Bhadravathi. Each one of these gates weigh over ten tons. Wonder how they slide up and down automatically? When the water level in the lake reaches the maximum permissible level, water rushes into the well and the float rises up. The balance weight descends down and all the eight gates are pulled up. The 'sluice vents' then begin to discharge. When the reservoir level falls, the wells get emptied. The balance weight then comes up and the gates descend and discharge is stopped. A complete novelty then, these gates have been copied all over the world, including the Panama Canal.

Other contributions of Sir M. Visvesvaraya Education

Sir MV's contributions also included a range of other activities which had a direct bearing on the development and modernisation of the country. Sir MV's foresight resulted in primary education being made compulsory in Mysore and also led to initiatives for educating girls.

Having lived up to the age of 101 years, the engineering contributions of Sir M. Visvesvaraya spanned over 80 years as an excellent engineer, a visionary nation builder and an exemplary human being.



(Photo: Poonam Chaurasia)

National Planning

Sir MV spoke about the planning model in the first decade of the 20th century. Pandit Jawaharlal Nehru, the first Prime Minister of India, borrowed the idea for planned economy from Sir M. Visvesvaraya.

Indian Institute of Science

Sir MV was the one who showed vision in starting the Department of Metallurgy, Department of Aeronautics and Internal Combustion Engine at Indian Institute of Science, Bengaluru. IISc, in recognition of his services to the institute and also to the society, conferred Honorary Fellowship on Sir M. Visvesvaraya, which he shared with Pandit Jawaharlal Nehru and Sir. C.V. Raman.

Visvesvaraya Iron and Steel Limited

Bhadravati, situated on the banks of the river Bhadra in the



Visvesvaraya Iron and Steel Ltd. (Photo: Poonam Chaurasia)

Shimoga district is yet another location where Sir MV's work still lives on. Bhadravati was selected by Sir M. Visvesvaraya to set up an industrial enterprise because he believed that steel was the basic ingredient to industrial growth. Bhadravati found favour because iron ore could be obtained from a nearby village called Kemmangundi. Limestone could come from Badigund, while dolomite was available at Shankargudda and the forests of Shivamogga were already a huge source of charcoal.

The only furnace of its kind in India, the charcoal blast furnace was installed in 1923 at Bhadravati which made it the first plant in Asia to undertake manufacture of pig-iron using charcoal, which would constitute the input for making the various grades of iron and steel later.

The celebration of Engineer's Day and the village 'Muddenhalli'

Mokshagundam Visvesvaraya was born on 15 September 1860 in a village called Muddenahalli, at the foothills of Nandi hills, 5 km from Chikballapur near Bengaluru. Sir MV passed away on 14 April 1962.

His birthday is celebrated in India as Engineer's Day. But for a boy who lost his father when he was just 12 and who had to support his own education by giving private tuition to students, his life holds a mirror to the times. For the villagers he is still like a messiah who had offered a means of livelihood to their ancestors and the one who went on to be a Bharat Ratna.

It was at the Central College, Bengaluru that he impressed the Principal Mr. Charles Waters so much that he gifted his personal copy of Webster's dictionary to Visvesvaraya.

It is said of Sir MV that while travelling by train he felt an unusual vibration while sleeping and thought it could be a broken track some distance away. He pulled the chain. A spot check was surprising enough. There, indeed, was a big crack in the rail a few metres away. The passengers were saved from a major mishap. Apart from scores of honours coming his way, Sir MV was also awarded the knight Commander of the Order of the Indian Empire.

The author is a science film maker and science communicator.
Email: matiurrahman@gmail.com



Hot Air Balloon: Then and Now

Till the eighteenth century the idea of man flying in the sky was absurd. Some courageous humans however thought of flying into the sky someday and eventually invented hot air balloons.

Recall the olden times when humans appeared on the Earth and started getting himself acquainted with the things around and gradually became familiar with the vast wealth of the Earth even conquered the depths of the sea and the height of the mountains. However, the sky just remained a curiosity; he kept looking at the skies, staring at the birds, only wondering if man could ever fly in the sky like them.

Two young French brothers, Joseph-Michel and Jacques-Étienne Montgolfier, living in a village named Annonay, near the French capital, had a similar vision. The two brothers used to make paper envelopes and play with them. One day they saw that an envelope filled with air and its opening closed tightly by tying with a thread, started rising upwards when it came close to a furnace. They noticed that when the air of the paper

bag heats up, it starts to rise. Now they made a big paper balloon and filled it with air and heated it for a longer time, the balloon swelled a little more due to the heated air. As soon as they released the balloon, it rose higher in the air, floated for some time and then landed back on to the ground. By now they had understood that if they fill hot air in the balloon, it would rise to a greater height. Then they made a huge balloon and took it to a field, filled it with smoky air coming out of a chimney, closed its opening, and then released it by opening the rope with which it was held to the ground. The balloon immediately started

to rise up in the air swaying and it went very high in the sky. After a while, as the filled hot air cooled down, the balloon came down to the ground. It was 5 June 1783, when an unmanned object flew in the air for the first time and gave rise to future possibilities of flying in the sky.

But the principle responsible for the rise of the balloon was yet to be understood. The Montgolfier brothers just knew that hot air is lighter than cold air, and so it rises up. Hence they named it Hot Air Balloon.

It did not take long to spread the news in the city of Paris that a huge balloon rose up in the sky to a great height. It was the reign of King Louis XVI of France. When this news reached him, he was very happy. He sent his congratulatory message to the Montgolfier brothers and expressed his desire to see this charisma with his own eyes. A date was set for the performance on 19 September 1783.

Other scientists who were working in this direction could not believe that the two brothers had done this miracle. In the team of these scientists was one Professor Jacques, who knew that there is a gas called hydrogen, which is lighter than air. Professor Jacques



made a rubber mix balloon; he wanted to show the flight of this balloon before 19 September 1783. He surprised everyone by blowing his hydrogen filled gas balloon into the air on 28 August 1783. Therefore, the credit for making the hydrogen gas balloon goes to Professor Jacques.

On the other hand, Etienne and Joseph presented a brilliant demonstration in presence of King Louis, on 19 September 1783. Not only this, they also put a basket at the bottom of the balloon in which a sheep, a duck and a chicken were kept. The flight began in front of the King and a vast gathering; after a while the balloon returned to Earth. Both the birds and the sheep returned safely.

Etienne and Joseph began to think, when these three creatures can return to Earth safely, why not humans! One of his scientist friends Jean-François Pilâtre de Rozier agreed to go, but the King's permission was needed for it.

One of Rozier's friends was François Laurent d'Arlandes, a nobleman, also known as a marquis. They met the King and took the permission for flying. Now both Rozier and Laurent d'Arlandes were to fly on 16 November 1783.

Etienne and Joseph felt that the hot air cools very quickly. So, to keep the balloon air warm for a longer time, they kept a coal stove in the basket tied to the balloon, so that the air in the balloon would remain warm.

At pre-fixed time, Rozier and Laurent d'Arlandes flew from the Royal Garden in front of the King's Palace and returned safely to Earth after about 20 minutes.

Meanwhile, Professor Jacques announced the flight of his hydrogen gas balloon. He took off in his balloon with one of his friends, Nicolas Robert, on 1 December 1783. There was neither a problem of heating the air in his balloon nor of keeping the air hot. It created a furore all over France. It was a risky task to keep the air hot in the balloons of Etienne and Joseph Montgolfier; so, shortly after the invention, the utility of hot air balloon began to decrease.

Hydrogen gas balloons started becoming popular all over Europe. However, there was a problem with

hydrogen gas balloon too. The gas catches fire very quickly. In 1785, Rozier flew in a hydrogen-filled balloon. His balloon caught fire and he was killed.

After this, helium gas, which is also lighter than air, was used to fill balloons for flying. Also, Helium does not catch fire. Helium gas balloons were trending in the sky for the next 200 years. In 1960, there were many changes in the world. In 1960, Paul Edward Yost, an American inventor turned his attention to the hot air balloon. He made some changes in the balloon and used LPG gas in the gondola to keep the balloon air hot and made a successful flight on 22 October 1960.

Hot air balloon again reached the peak of popularity due to the efforts of Yost. Balloon flights are so popular in Europe, US, Canada and France that balloon fairs are held there every year and it has got the status of Air Sport. Most balloons are round in shape. But balloons of different shapes are also flown at the Balloon Fair.

The popularity of hot air balloons is increasing in India too. Vishwabandhu Gupta is credited with bringing this air sport to India. He is the founder

of Ballooning Club of India. In 2005, Indian industrialist Vijaypat Singhanian set a world record by rising to a height of 8,600 m in a hot air balloon in Mumbai.

A hot air balloon floats in the air at an altitude of several hundred metres. It does not require heavy engines; only hot air is its fuel. In the normal state with complete freedom, there is no heavy machine, no engine, no noise nor any variety of components and equipment.

A Hot air balloon is made of nylon fabrics that can bear a temperature of 121.11°C or of dacron which can bear up to 162.77°C. Large pieces of cloths strips are joined and sealed. The pieces are cut and sealed in such a way that after filling the air they spread and turn into the shape of a balloon.

Many balloons are up to 7 floors high. It is then filled with air with the help of a very large fan, though an opening which is about 1.5m in diameter. The fan is removed after filling air. After this, the balloonist pilot turns on the gas burner kept in the gondola that hangs below. Depending on the size of the balloon, the gas cylinder may have one to four burners. Soon, the air present inside the balloon starts heating up and its temperature reaches 34°C, and the balloon starts rising in the air.

As the air inside the balloon cools down, the balloon starts coming down. The balloonist can turn on the gas burner whenever he wants and when he wants to return to the Earth he pulls a rope that opens a lid on the roof of the balloon. The hot air starts leaking out of the balloon and it starts coming down.

Hot air balloons cannot return to the place from which they fly, because, the wind takes it along with it. Hence the balloonists maintain contact with their colleagues present on the ground. When he gets very close to the ground, he throws a rope down with the help of which his colleagues there grab the rope and pull the balloon down to the ground.

In the basket at the bottom of the balloon a duck, a sheep and a chicken were kept. The flight began in front of the King and a vast community gathering. After a while the balloon returned to Earth. Both the birds and the sheep returned safely.



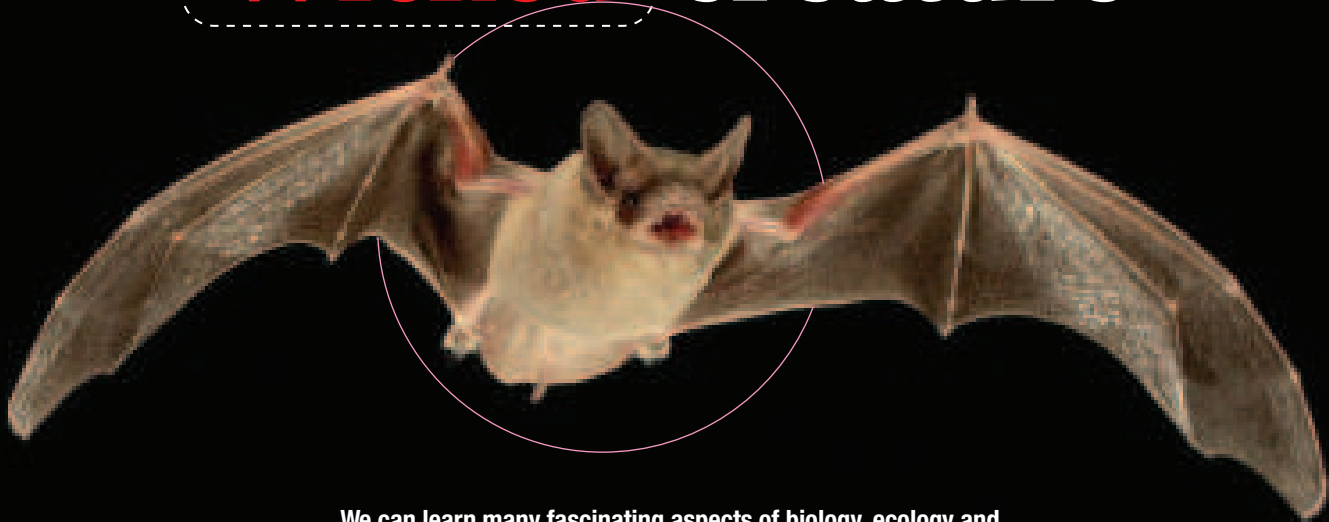
The author is a former glider pilot and a science writer.

Email: madanmohannayyar@gmail.com

Translator: Ram Sharan Das



I am not a **Wicked** creature



We can learn many fascinating aspects of biology, ecology and immunity from bats. It is important to clarify myths associated with them and highlight their important role in maintaining our ecosystem.

The common Asian folklore symbolises bats as carrier of bad luck. Whereas, in ancient Feng Shui (traditional practice in China), bats symbolize good luck and happiness. Many of us grew up listening to stories of haunted house inhabited by bats and how these sinister creatures attack human beings and drink their blood. These winged animals evoke aversion and fear in many of us and recently they were back in our discussion due to emerging evidence that bats serve as reservoir of viruses including the SARS-CoV-2 that causes COVID-19. Social media were quick to circulate the verdict that bats are monsters and a threat to mankind. Fear of spread of COVID-19 by bats resulted in rampant killing of bats, use of heavy pesticides and even cutting-down trees to destroy their habitat. In the midst of this fear and anxiety, the efforts of Shantaben Prajapati, a 74-year-old resident of Rajpur, Gujarat were never highlighted. She has given shelter to more than 400 bats in her house and is fondly called “chamachidiya wala ba”

(grandma living with bats).

With so much of misinformation about bats floating around, it is important to clarify myths associated with them and highlight their important role in maintaining our ecosystem. Bats belong to order Chiroptera, which comes from Greek words “Chiro” (hand) and “ptera” (wing). Chiroptera is the second most species-rich order of mammals after Rodentia. Bats constitute one-fifth of mammalian species and the only mammal that can fly. These are interesting to study evolution, metabolism, longevity, social behaviour, immunity and zoonotic infections.

Globally, there are over 1,300 bats species and they mainly feed on fruits, nectar, insects and mosquitoes. Vampire bats comprise of three species, out of which one species feeds on human blood. Based on their size, they are classified as megabats and microbats. To support their airborne activities, bats maintain high metabolic rates. They have undergone adaptive evolution

of metabolism-associated genes and antioxidant system to acclimatise to environmental perturbations. As we know that oxidative stress and mitochondrial dysfunction has been associated with aging-related diseases. Bat’s mitochondrial DNA harbours lesser number of DNA repeats than other mammals and it produces lesser reactive oxygen species (ROS) which results in long lifespan of bats compared to similarly-sized mammals.

The phrase “as blind as a bat” is commonly used to mock people. However, this phrase is scientifically incorrect. Bats can see better than humans and while hunting, bats sometimes prefer using eyesight over sound. Some bats use echolocation to navigate and track their food in the dark. Bats can manoeuvre better than birds and can change direction quickly. They can catch mosquitoes even during flight; and thus prevent transmission of mosquito-borne diseases. Bats are also efficient predators of crop pests and consume insects, equivalent to 30%

I am non-violent



I am nature's pest control

100% of their own body mass which especially benefits crops like cotton, corn, coffee and sorghum. Whereas frugivorous bat feeds on mango, guava, litchi, cashew and other fruits. Their feeding habit (nectar and fruit) and mobility facilitates pollination and seed dispersal. This allows maintenance of biodiversity and regeneration of forests. Even its guano is very effective manure as it is rich in nitrogen, phosphorus and potassium content.

Bats are socially intelligent creatures and exhibit altruistic behaviour such as blood sharing by vampire bats. The saliva of the common vampire bat (*Desmodus rotundus*) contains an anticoagulant compound called salivary plasminogen activator (Desmoteplase) which helps in rapid lysis of fresh blood clots and can have promising effect in treatment of stroke caused by clots in brain blood vessels.

Another unique social behaviour exhibited by bats is roosting in large colonies on trees, caves, rock crevices and abandoned buildings. The example of roosting colony is Bracken cave (in San Antonio, Texas, USA), the largest congregation of bats in the world. Fifteen million Mexican free-tailed bats roost every summer and nursing mothers

share their body heat, food and take care of baby bats.

Bat conservation international (BCI) has taken many initiatives to conserve bracken cave and protect endangered bat species. In India, geo-climatic and vegetational differences nurture diversity in bat species (8 families, 39 genera, 117 species, according to Zoological Survey of India). They are abundant in West Bengal, Meghalaya, Uttar Pradesh, Madhya Pradesh, Gujarat, Maharashtra, Karnataka, Kerala and Andaman-Nicobar islands. Mammal Survey of India carried out systematic surveys across the country.

However, comprehensive investigation of the diversity of bats, identification of endangered species and initiatives towards their conservation are also needed.

Emerging evidence indicates that bats serve as a natural reservoir for many RNA viruses such as Ebola, Rabies, Marburg, Nipah, retroviruses (AIDS-like virus), and SARS. Bats can also harbour bacterial, fungal and protozoan pathogens, but our understanding of bats-to-human transmission or zoonotic spill-over is limited. Their social roosting makes them vulnerable to many fungal infections, such as white-nose fungal infection, which has caused substantial decline in bat population. Bat populations encounter seasonal fluctuations in food availability and face threat due to anthropogenic disturbances to their habitat. All these factors affect pathogen release from reservoir-host, pathogen survival or dissemination (through vector or intermediate host) and human exposure to pathogen.

Bats are nature's incubators that harbour many virulent viruses without experiencing disease. Research has shown that bats have super-immunity to viral pathogens mediated through interferon pathway and antibody response. Unlike other mammals, bats have evolved unique anti-inflammatory traits which

Bats

can see better than humans and while hunting, bats sometimes prefer using eyesight to sound. Some bats use echolocation to navigate and track their food in the dark. Bats can manoeuvre better than birds and can change direction quickly. They can catch mosquitoes even during flight; and thus prevent transmission of mosquito-borne diseases.



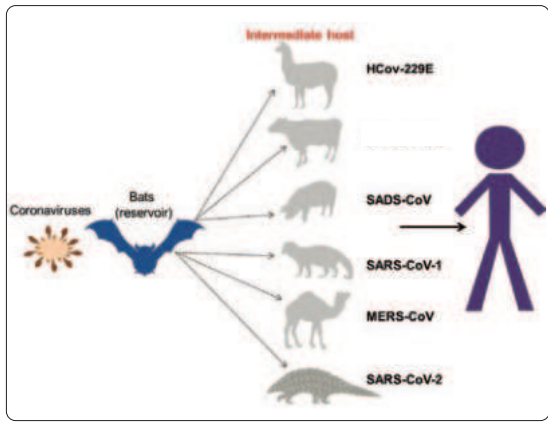
I maintain ecological balance

include the loss of certain genes that promote inflammation and alleviate ROS-induced damage. As bats mount immune response to curb viral multiplication, the persistence of pathogens in reservoir host may impose "an arms race" for pathogens to evolve faster and infect new cells to ensure successful transmission.

We can learn many fascinating aspects of biology, ecology and immunity from bats; however, not many labs across the globe are working on these fundamental aspects. With the rise in zoonotic infections, it is important to initiate concrete efforts across the globe to strengthen our understanding of dynamics between wildlife and emerging infectious diseases. There are still many unanswered questions, for instance, (a) How does hibernation or their biological clock (circadian rhythms) affect maintenance of viral load in bats? (b) How does their roosting/altruistic behaviour affect inter-species transmission of pathogen, (c) Can bat's neutralising antibodies show promising effect in controlling infection in humans? Comprehensive inter-disciplinary efforts of research labs across the world will help in knowledge and capacity building, so that we can collectively manage the emerging and re-emerging zoonotic infections.

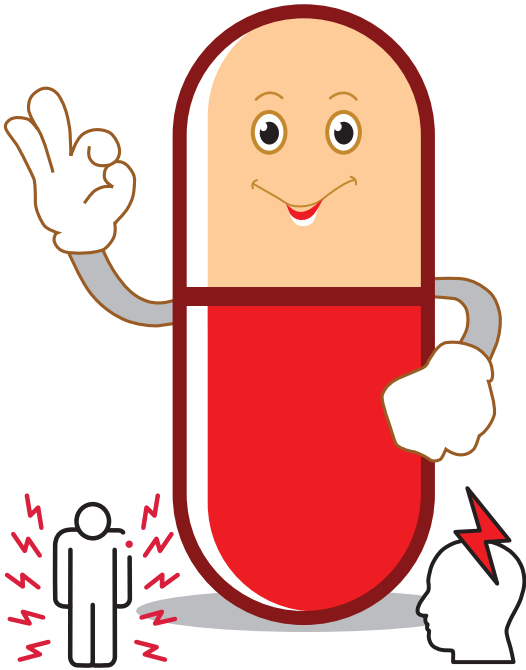


I am a social creature



Zoonotic spill-over of coronaviruses from bats to humans via intermediate host. Adapted from Cui et al, 2019, Nature Reviews Microbiology and Lam et al 2020, Nature

Ms Varsha Kumari is UGC-Senior Research Fellow and Dr Niti Kumar is Senior Scientist in CSIR-Central Drug Research Institute, Lucknow. Email: nitikumar@gmail.com; nitikumar@cdri.res.in



Know your Medicine: PARACETAMOL

Paracetamol is a well-known over-the-counter medicine commonly used to relieve pain and bring down fever. It is considered by The World Health Organization to be an essential medicine in a basic health system.

(fever reducing) and analgesic (pain relieving) properties. They quickly published their research and acetanilide was introduced into medical practice in 1886 under the name of antifebrin.

Soon they observed that although the production cost of this drug was very low, acetanilide could not be used as an antipyretic agent due to its high toxicity. This resulted in a great deal of research on less toxic derivatives of acetanilide. Finally, after long research, its acetyl derivative, which was already synthesised by Morse, appeared to be the most satisfying compound.

After its first synthesis in 1878, paracetamol became available to the general public with a doctor's prescription in 1953. It was not until 1959 that paracetamol became available without a prescription. Today, paracetamol is a well-known medicine used for pain and fever.

Paracetamol is most commonly used as analgesic and is recommended as the first-line therapy to relieve pain by the World Health Organization (WHO). It is also used for its antipyretic effects, helping to reduce fever.

Paracetamol provides relief from several common medical conditions such as headaches, muscle aches and pains, toothaches, arthritis, and fever. Paracetamol is often used combined with other drugs in more than 600 over-the-counter (OTC) allergy medications, cold medications, sleep medications, pain relievers, and other products.

Because of its low risk of causing allergic reactions, paracetamol can be administered in patients who are intolerant to salicylates and those with allergic tendencies, including those with bronchial asthma. However, special

guidelines need to be followed when administering it to children.

Mode of action

Animal and clinical studies have determined that paracetamol has both antipyretic and analgesic effects. It probably works by reducing the intensity of pain signals to the brain. It may also prevent the release of substances called prostaglandins that increase pain and body temperature. In human brain, the hypothalamus works as a thermostat and it controls body temperature. During fever, a protein called pyrogen is generated. This increases the synthesis of compounds called prostaglandins in the hypothalamus, raising its temperature



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Paracetamol and acetaminophen are two official names of the same chemical compound N-(4-hydroxyphenyl) ethanamide having molecular formula $C_8H_9NO_2$.

Paracetamol was first synthesised by Harmon Northrop Morse, an American chemist in 1878. Two young doctors Arnold Chan and Paul Heppa at the University of Strasbourg, France, were



Harmon Northrop Morse

studying how naphthalene affected intestinal parasites (worms), but they received acetanilide by mistake. To their surprise they found that although acetanilide did not have much impact on intestinal parasites, it had antipyretic

set point. Paracetamol acts as an antipyretic and inhibits the synthesis of prostaglandin. It reduces fever by promoting heat loss through sweating and cutaneous vasodilation and thus helps to lowering the body temperature.

Precautions

Paracetamol has few side effects when taken at recommended doses. However, it is better to consult the doctor before taking paracetamol if you have liver or kidney problems or if you are taking other medicines because paracetamol may interfere with some of them. It is advisable not to take paracetamol if you are allergic to it.

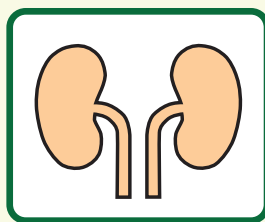
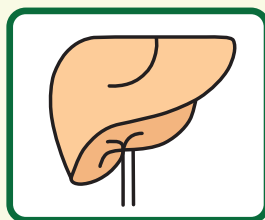
Paracetamol and liver failure

Paracetamol is one of the most commonly used medicines for its analgesic and antipyretic properties. It is safe and effective at recommended doses, whereas overdose may lead to acute liver failure. In fact, paracetamol-induced liver damage has been observed in many countries. Attempts have been made by various researchers to understand the mechanisms of its toxicity. Generally, paracetamol-induced oxidative stress and mitochondrial dysfunction plays the key role in this. The United States Food and Drug Administration recommend N-acetyl cysteine, a well-known antioxidant, as the only therapeutic option for patients affected by paracetamol overdose; however, this treatment has its limitations including adverse effects and narrow therapeutic range. In the early stages, if the patients are not cared for properly, liver transplantation is the only option for their survival.

Hence, the development of new drugs that are superior to N-acetyl cysteine, in terms of effectiveness and therapeutic time frame, is the need of the day. Recently, there have been intensive researches demonstrating the protective effects of natural products against paracetamol-induced hepatotoxicity, throwing up several future drug candidates. It has been recognised that the paracetamol-induced liver toxicity consists of multi-stages and multi-



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signalling pathways, including metabolic activities, oxidative stress, endoplasmic reticulum (ER) stress, autophagy, sterile inflammation, microcirculatory dysfunction, and compensatory liver repair and regeneration.

Many genes or molecules have been identified to play important roles in the regulation of paracetamol hepatotoxicity, so they are suggested to be potential targets for therapeutic intervention against paracetamol-induced liver damage.

When administered at therapeutic doses, most of the paracetamol is metabolised by phase II conjugating

enzymes, mainly UDP-glucuronosyl transferase (UGT) and sulfotransferase (SULT), converting it to nontoxic compounds which are then excreted with the urine. Only a very small portion is excreted unchanged in the urine. The remaining paracetamol, approximately 5–9%, is metabolised by the cytochrome P450 enzymes (CYPs), mainly CYP 2E1 into the highly reactive intermediate metabolite N-acetyl-p-benzoquinone imine (NAPQI).

Paracetamol and kidney failure

Paracetamol-induced liver necrosis has been studied extensively, but the manifestations of paracetamol toxicity outside the liver are currently not studied well in the available literature and it occurs in approximately 1-2% of patients with paracetamol overdose. Paracetamol-induced kidney failure studies have revealed that paracetamol is mostly metabolised through processes known as glucuronidation and sulfation whereas lesser portion of drug is metabolised through oxidation by P-450 enzyme system. Metabolites are primarily generated in liver and are excreted through kidney. At therapeutic doses, N-acetyl-p-benzoquinoneimine (NAPQI) that is generated from oxidized paracetamol is reduced to mercapturic acid by glutathione. Overdose of paracetamol depletes both glutathione and sulphate, then metabolic pathway slides to oxidation. This situation resulted lipid peroxidation that causes cell damage and apoptosis. Oxidation of paracetamol by cytochrome P-450 system that may result in tubular damage and potentialisation of the process by the depletion of glutathione in kidney is also mentioned. Apoptosis induced by paracetamol has been shown in animal studies. In another study, it has been shown that paracetamol increases reactive oxygen radicals such as nitric oxide and this also contributes to cell damage.

Dr Keshav Lalit Ameta, Professor and Head
Department of Chemistry, School of Liberal Arts
and Science, Mody University of Science and
Technology, Lakshmangarh- 332311 (Rajasthan)
Email: klameta.cash@modyuniversity.ac.in

PROF AMALENDU BANDYOPADHYAY:



The man who brought the stars closer to common people

There are people, may be very few in numbers, who take science communication passionately and do whatever they can to take science to the common man. Prof Amalendu Bandyopadhyay is one such name. There are many superstitions and misbeliefs in our society associated with celestial bodies and events. Prof. Bandyopadhyay was one among those in independent India who was at the forefront working actively to counter unscientific beliefs and build scientific temper in the country.

Amalendu Bandyopadhyay was born in the village of Mugkalyan in West Bengal on 1 February 1930. After completing school education in his village, he received his college education in Benaras Hindu University and got his M.Sc. degree in mathematics in the year 1952. He was fortunate to study astronomy at BHU under eminent mathematician Prof. Vishnu Vasudev Narlikar (father

of eminent Indian astrophysicist Prof. Jayant Vishnu Narlikar) who was the head of the Department of Mathematics. After passing out from university, Bandyopadhyay served as a lecturer in mathematics in D.A.V. College in Varanasi for about four years from 1952 to 1956.

After independence, the Government of India used the Gregorian calendar or the commonly known English Calendar for official use. But divergent practices prevailed for observing festivals in different states of the country. Nearly 30 different Panchangs were in use during post-independent India, which created a lot of confusion regarding festival dates. Therefore, a need was felt by the then Prime Minister Pt. JawaharLal Nehru to develop a unified National Calendar on the basis of the most accurate modern astronomical data in the interest of national integrity. Keeping these in view, a Calendar

Reform Committee was formed in 1952 under the Council of Scientific and Industrial Research of the Government of India with world famous Indian astrophysicist Prof. Meghnad Saha, FRS, as Chairman. The committee recommended preparation of the Indian Ephemeris, Nautical Almanac and the National Calendar of India (using Saka Era) with timings of tithis, nakshatras, yoga, etc., and also festival dates. The committee also recommended the preparation of a Rashtriya Panchang with solar calendar system for civil purposes and luni-solar calendar system for religious purposes. The recommendations of Calendar Reform Committee were taken up by the India Meteorological Department on 1 December 1955. The unit, which was functioning as the office of the Calendar Reform Committee at the then Institute of Nuclear Physics, Calcutta, was brought under control of the Regional Meteorological Centre, Calcutta (now Kolkata) as one of its sections named 'Nautical Almanac Unit'. In 1956, Prof. Bandyopadhyay joined the Nautical Almanac Unit at Kolkata. In 1968, he took the entire responsibility of the Nautical Almanac Unit. Due to his untiring and dedicated efforts for 12 long years, the Nautical Almanac Unit was ultimately converted into an international centre named as the Positional Astronomy Centre (PAC) in Kolkata under India Meteorological Department (IMD) in 1979. Prof. Bandyopadhyay became its first Director. The PAC is the only centre of its kind in India and one of the eight similar international centres of positional astronomy in the world. Bandyopadhyay retired from this institution in 1988.

In 1989, Bandyopadhyay joined the Research Division of the M.P. Birla Planetarium (now M.P. Birla Institute of Fundamental Research), Kolkata as a Senior Scientist. Till the last day of his life, Prof. Bandyopadhyay was one of the teachers at this institute for Post Graduate Diploma Course in Astronomy and Planetarium Science.

Prof. Bandyopadhyay received many academic recognitions from India and

abroad. He was elected member of the International Astronomical Union, Fellow of the Royal Astronomical Society of London, Fellow of the British Astronomical Association, and Fellow of the West Bengal Academy of Science & Technology. He presented research papers at astronomical centres in the US, England, France, Italy, China, Japan and Korea. He was associated with Vigyan Prasar and was member of the executive committee from 1996 to 2000. In 2009, he received a special invitation and addressed the students of universities in Bahrain, Abu Dhabi and Dubai.

Prof. Bandyopadhyay was a prolific science communicator for the common man. He wrote eight books on popular astronomy (3 in English and 5 in Bangla). More than 2,500 of his articles on popular science topics in English and Bangla were published in journals and newspapers of repute all over India. He valuably contributed in electronic media

of radio and television. Bandyopadhyay's favourite passion was to deliver lectures with slides on popular topics of astronomy in schools, colleges, universities and rural areas far away from cities.

In recognition of his lifetime contribution to science popularisation, mainly in the field of astronomy, Prof. Bandyopadhyay was awarded the prestigious NCSTC National Award for outstanding effort in science communication by Govt. of India in 1995, and the Gopal Chandra Bhattacharya Memorial Award—the highest award for science popularisation from Government of West Bengal in 2001. The University of Burdwan conferred on him the prestigious D.Sc. degree (Honoris Causa) in 2003. Calcutta University awarded him with prestigious 'Jagattarini Gold Medal' for writing and communicating astronomy in Bangla. He received the 'G.P. Chatterjee Memorial Award' from Indian Science Congress Association

in 2013. He lived a very simple life. He always used public transport to come to Birla Planetarium to take the classes. The only hobby of this great man was to collect and listen to gramophone records of Tagore songs.

Prof. Amalendu Bandyopadhyay left for his heavenly abode on 22 June, 2020 at the age of ninety in Kolkata. With his demise he left behind a trail of students and science communicators who follow his path and try to bring the stars closer to common people.

On behalf of Vigyan Prasar we express our deep respect and gratitude to the departed soul and wish to convey our heartfelt condolences to his family.

Dr BK Tyagi is Scientist F in Vigyan Prasar and Ayan Kumar Saha is a Science Communicator and Demonstrator with Tripura State Council for Science & Technology.

Emails: bktyagi@vigyanprasar.gov.in; ayan_saha@yahoo.co.uk

← Continued from page 3

NEW CATALYST TURNS CO₂ TO FUEL AND PLASTIC WASTE TO CHEMICALS

Catalysts play a key role in many industrial processes. The commonly used industrial catalysts include what are called solid state acids. Many common organic acids such as oxalic acid, tartaric acid, citric acid, maleic acid, etc., are solid state acids. Other examples include oxides, including silico-aluminates (zeolites, alumina, silico-alumino-phosphate), and sulphated zirconia, which function as catalysts. Many transition metal oxides are acidic, including titania, zirconia, and niobia. Such acids find use in a variety of applications such as catalytic cracking in petroleum refining to the synthesis of various fine chemicals.

Recently, researchers at Tata Institute of Fundamental Research (TIFR),

Mumbai, have come up with a novel process that uses nano solid acids to transform carbon dioxide directly to fuel (dimethyl ether) and plastic waste into chemicals (hydrocarbons). The researchers say the technique can help solve two major environmental problems – of global warming and plastic waste – in one stroke.

It is well known that the primary cause of global warming in terms of drastic changes in weather patterns is atmospheric carbon dioxide the levels of which are rising every day. There is, therefore, a great need to find ways to reduce carbon dioxide levels.

Two best known solid acids are crystalline zeolites and amorphous aluminosilicates. Although zeolites are strongly acidic, they are limited by their inherent microporosity—extremely small size of their pores—that severely limits diffusion limitation. On the other hand, aluminosilicates are mesoporous—with larger sized pores, but they suffer from low acidity and moderate stability.

The researchers therefore had to take up the challenge to design and synthesise solid acids with both strong acidities

like zeolites and textural properties like aluminosilicates, speculated as “amorphous zeolites,” which are ideally strongly acidic amorphous aluminosilicates. By using a technique called ‘bicontinuous microemulsion’ droplets as a soft template, Prof. Vivek Polshettiwar's group at TIFR were able to achieve success and synthesise amorphous zeolites with a nano-sponge morphology, exhibiting both zeolitic (strong acidity) and amorphous aluminosilicate (mesoporous high surface area) properties. These synthesised nano-solid acids can transform carbon dioxide directly to fuel (dimethyl ether) and plastic waste to chemicals (hydrocarbons).

The researchers are hopeful that the approach may allow the development of solid acid catalysis for plastic degradation as well as conversion of carbon dioxide to fuel at the significant rates, scales, and stabilities required to make the process economically competitive.

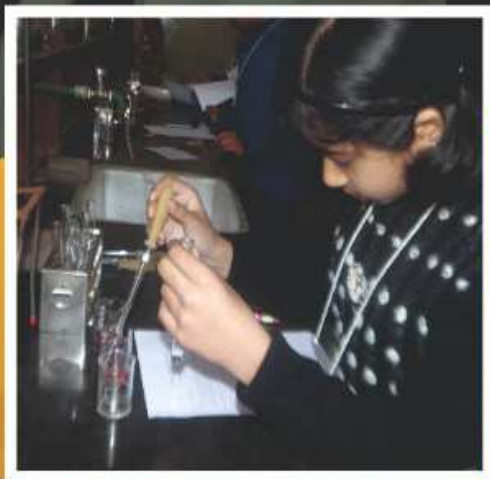
Biman Basu is a former editor of the Science Reporter, published by CSIR.
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