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NEWS ALERT

Forum for Indian Science Diplomacy

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CONTENTS

GLOBAL

Fertilizer Production without Carbon Emissions

Researchers investigated various carbon-neutral production methods for nitrogen fertiliser. They concluded that a transition in nitrogen production may also increase food security. They examined three alternative production methods by producing the necessary hydrogen using fossil fuels as in the business-as-usual, only instead of emitting the greenhouse gas CO2 into the atmosphere, it is captured in the production plants and permanently stored underground (carbon capture and storage, CSS). The second method used electrifying fertiliser production by using water electrolysis to produce the hydrogen. The third by synthesising the hydrogen for fertiliser production from biomass. The scientists state that the key to success is likely to be a combination of all these approaches depending on the country and on specific local conditions and available resources. These approaches can be combined depending on the country and on specific local conditions and available resources.

New Mechanism to Boost RNA Therapies

Investigators from the Smidt Heart Institute have identified how biological pacemaker cells can 'fight back' against therapies to biologically correct abnormal heartbeat rates. The research also uncovered a new way to boost the effectiveness of RNA therapies by controlling this activity. They harnessed the same modified messenger RNA (mRNA) technology used in creating the Pfizer and Moderna COVID-19 vaccines. MRNA carries information from genes to make proteins, the building blocks of life. They injected laboratory mice with mRNA that was chemically modified to express a protein called TBX18. In doing so, they found that heart cells "fought back": They inhibited TBX18 protein expression by producing microRNAs, nature's own regulatory molecules that specifically fine-tune gene expression. As a result, the amount of TBX18 protein produced was insufficient to support the heartbeat. The team looked for a way to bypass the suppressive effect of the microRNAs. After identifying the precise microRNAs involved, the investigators used chemical antagonists to specifically suppress those microRNAs, increasing TBX18 protein expression, and stabilizing the heartbeat. They found a similar reaction -- the cells' ability to fight back -- is at play in limiting the expression of VEGF-A, an alternative type of chemically modified messenger RNA that has been used to grow new blood vessels. They will also assess the long-term efficacy and safety, with a view to eventually apply the insights to improve the efficacy of mRNA therapy in clinical trials.

Enzyme Inhibition Promotes Bone Formation

Researchers at the German Cancer Research Center have identified an enzyme that controls the activity of osteoblasts. An agent that inhibits the activity of this enzyme reduces cancer-related bone loss and the number of bone metastases in multiple myeloma and in lung and breast cancer models in mice. The team identified in mouse osteoblasts the two enzymes MERTK and Typo3, so-called receptor tyrosine kinases, which regulate bone production. The function of the two enzymes was studied in mice in whose osteoblasts either one or the other receptor tyrosine kinase was genetically switched off. The result was an indication that the activity of MERTK in osteoblasts could also contribute to the cancer-related inhibition of bone formation. They are further investigating the role of MERTK as a therapeutic target in pathological bone loss.

Antibiotics to Target Multiple Drug Resistant Bacteria Developed

Hokkaido University researchers have designed and synthesized analogs of a new antibiotic that is effective against multidrug-resistant bacteria, opening a new front in the fight against these infections. The team worked on a class of antibacterial compounds called sphaerimicins which block the function of a protein in the bacteria called MraY. MraY is essential for the replication of bacteria and plays a role in the synthesis of the bacterial cell wall; it is also not a target of currently available commercial antibiotics. The drug designed was effective against methicillin-resistant *Staphylococcus aureus* (MRSA) and vancomycin-resistant *Enterococcus faecium* (VRE), two of the more common multi-drug resistant bacteria. The team analysed structures of sphaerimicin A by molecular modelling assisted by calculation, and designed and synthesized two analogs of sphaerimicin, SPM1 and SPM2. These analogs were found to be effective against Gram positive bacteria. They were successful in developing a simpler analog, SPM3, whose activity was similar to SPM1. In addition to their effectiveness against MRSA and VRE, the SPMs were also effective against *Mycobacterium tuberculosis*, the bacteria that causes tuberculosis -- and which has multidrug-resistant strains.

Biomarker Test Can Detect Alzheimer's Neurodegeneration

Neuroscientists led by a University of Pittsburgh School of Medicine researcher developed a test to detect a novel marker of Alzheimer's disease neurodegeneration in a blood sample. The biomarker, called "brain-derived tau," or BD-tau, outperforms current blood diagnostic tests used to detect Alzheimer's-related neurodegeneration clinically. They designed a special antibody that selectively binds to BD-tau, making it easily detectable in the blood. They validated their assay across over 600 patient samples from five independent cohorts, including those from patients whose Alzheimer's disease diagnosis was confirmed after their deaths, as well as from patients with memory deficiencies indicative of early-stage Alzheimer's. The tests showed that levels of BD-tau detected in blood samples of Alzheimer's disease patients using the new assay matched with levels of tau in the CSF and reliably distinguished Alzheimer's from other neurodegenerative diseases. Levels of BD-tau also correlated with the severity of amyloid plaques and tau tangles in the brain tissue confirmed via brain autopsy analyses. They are planning to conduct large-scale clinical validation of blood BD-tau in a wide range of research groups, including those that recruit participants from diverse racial and ethnic backgrounds, from memory clinics, and from the community.

Bacterial Therapy to Treat Lung Cancer

Columbia Engineering researchers have developed a preclinical evaluation pipeline for characterization of bacterial therapies in lung cancer models. Their study combines bacterial therapies with other modalities of treatment to improve treatment efficacy without any additional toxicity. This new approach was able to rapidly characterize bacterial therapies and successfully integrate them with current targeted therapies for lung cancer. The team used RNA sequencing to discover how cancer cells were responding to bacteria at the cellular and molecular levels. They built a hypothesis on which molecular pathways of cancer cells were helping the cells to be resistant to the bacteria therapy. To test their hypothesis, the researchers blocked these pathways with current cancer drugs and showed that combining the drugs with bacterial toxins is more effective in eliminating lung cancer cells. They validated the combination of bacteria therapy with an AKT-inhibitor as an example in mouse models of lung

cancer. The team aims to expand the study to larger studies in preclinical models of difficult-to-treat lung cancers and collaborate with clinicians to make a push for the clinical translation.

COVID-19

COVID-19 (WORLD)

China's Zhejiang has One Million Daily COVID-19 Cases, Expected to Double

China's Zhejiang, a big industrial province near Shanghai, is battling around a million new daily COVID-19 infections, a number expected to double in the days ahead, the provincial government said on 25 December. Despite a record surge of cases nationwide, China reported no COVID-19 deaths on the mainland for the five days through Saturday. Citizens and experts have called for more accurate data as infections surged after Beijing made sweeping changes to a zero-COVID policy that had put hundreds of millions of its citizens under relentless lockdowns and battered the world's second-largest economy. Nationwide figures from China had become incomplete as the National Health Commission stopped reporting asymptomatic infections, making it harder to track cases. On 25 December, the commission stopped reporting daily figures. Zhejiang is among the few areas to estimate their recent spikes in infections including asymptomatic cases. Zhejiang, with a population of 65.4 million, said that among the 13,583 infections being treated in the province's hospitals, one patient had severe symptoms caused by COVID-19, while 242 infections of severe and critical conditions were caused by underlying diseases. China narrowed its definition for reporting COVID-19 deaths, counting only those from COVID-caused pneumonia or respiratory failure, raising eyebrows among world health experts. The World Health Organization has received no data from China on new COVID-19 hospitalizations since Beijing eased its restrictions. The cities of Qingdao and Dongguan have each estimated tens of thousands of daily COVID-19 infections recently, much higher than the national daily toll without asymptomatic cases. The country's health care system has been under enormous strain, with staff being asked to work while sick and even retired medical workers in rural communities being rehired to help grass-root efforts, according to state media. Bolstering the urgency is the approach of the Lunar New Year in January, when huge numbers of people return home.

BF.7 Omicron COVID Subvariant Spreading

Coronavirus subvariant, BF.7, has recently been identified as the main variant spreading in Beijing, and is contributing to a wider surge of COVID infections in China. BF.7, short for BA.5.2.1.7, is a sub-lineage of the Omicron variant BA.5. Reports from China indicate BF.7 has the strongest infection ability out of the Omicron subvariants in the country, being quicker to transmit than other variants, having a shorter incubation period, and with greater capacity to infect people who have had a previous COVID infection, or been vaccinated, or both. BF.7 is believed to have an R0, or basic reproduction number, of 10 to 18.6. This means an infected person will transmit the virus to an average of 10 to 18.6 other people. Research has shown Omicron has an average R0 of 5.08. The high transmission rate of BF.7, taken with the risk of hidden spread due to the many asymptomatic carriers, is understood to be causing significant difficulty in controlling the epidemic in China. The symptoms of an infection with BF.7 are similar to those associated with other Omicron subvariants, primarily upper respiratory symptoms. Patients may have a fever, cough, sore throat, runny nose, and fatigue, among other

symptoms. A minority of people can also experience gastrointestinal symptoms like vomiting and diarrhoea. BF.7 may well cause more serious illness in people with weaker immune systems. BF.7 carries a specific mutation, R346T, in the spike protein of SARS-CoV-2 which has been linked with enhancing the capacity of the virus to escape neutralizing antibodies generated by vaccines or previous infection. BF.7 has been detected in several other countries around the world including India, the U.S., the UK, and several European countries such as Belgium, Germany, France and Denmark. Despite BF.7's immune-evasive characteristics, and worrying signs about its growth in China, the variant seems to be remaining steady elsewhere. For example, in the US it was estimated to account for 5.7 per cent of infections up to Dec. 10, down from 6.6 per cent the week prior. In UK, in October it accounted for over 7 per cent of cases. It is not known why the situation looks different in China.

COVID-19 Booster Increases Durability of Antibody Response

The new findings by researchers from the University of Virginia School of Medicine shed light on how mRNA boosters – both Pfizer and Moderna – affect the durability of our antibodies to COVID-19. A booster, the researchers report, made for longer-lasting antibodies for all recipients, even those who have recovered from a COVID-19 infection. They made for longer-lasting antibodies for all recipients, even those who have recovered from a COVID-19 infection. Thus, longer-lasting antibodies would be expected to provide more sustained immunity against severe COVID-19. The researchers found that the antibodies generated by the Moderna booster proved longer lasting than those generated by the Pfizer booster. Moderna's antibody levels exceeded Pfizer's out to five months, the end of the study period.

COVID-19 (INDIA)

Bharat Biotech's Nasal Covid Vaccine for Adults Approved

The Indian government has approved the use of Bharat Biotech's nasal Covid vaccine iNCOVACC to be included in the country's vaccination programme as a booster dose for those above 18 years of age.Those who have taken Covishield and Covaxin can take the nasal vaccine as a heterologous booster dose. The vaccine will be available on the CoWIN app starting 23 December.The vaccine will be available in private hospitals and will be included in the Covid-19 vaccination programmes. The CoWIN platform will also be modified in this regard. In November, Bharat Biotech International Limited (BBIL) announced that iNCOVACC (BBV154), has received approval from the Central Drugs Standard Control Organisation (CDSCO) under Restricted Use in Emergency Situation for ages 18 and above, in India, for heterologous booster doses. iNCOVACC is a recombinant replication-deficient adenovirus vectored vaccine with a pre-fusion stabilised SARS-CoV-2 spike protein. The vaccine has been specifically formulated to allow intranasal delivery through nasal drops. The nasal delivery system has been designed and developed to be cost-effective in low- and middle-income countries. The vaccine was developed in partnership with Washington University, St. Louis, which had designed and developed the recombinant adenoviral vectored construct and evaluated in preclinical studies for efficacy.

Omicron's XBB.1.5 Variant in India

India has confirmed its first case of Omicron's XBB.1.5 in Gujarat. XBB.1.5 is a sub-variant that international scientists have flagged for being responsible for a surge in COVID cases and

hopitalisations in New York. It is a recombinant of two different BA.2 sub-variants of Omicron. XBB was first identified in India in August and quickly became dominant in the country. But its descendant, XBB.1.5 is believed to have a tighter bind to the ACE2 receptor, which would explain its higher level of transmissibility. XBB has greater immune evasiveness than others and it is adding more mutations like XBB.1.5.

INDIA–SCIENCE & TECHNOLOGY

Ancient Grammatical Puzzle Solved after 2,500 years

A grammatical problem which has defeated Sanskrit scholars since the 5th Century BC has finally been solved by an Indian PhD student at the University of Cambridge. Rishi Rajpopat made the breakthrough by decoding a rule taught by "the father of linguistics" Pāṇini. The discovery makes it possible to 'derive' any Sanskrit word using Pāṇini's revered 'language machine' which is widely considered to be one of the great intellectual achievements in history. Pāṇini's system -- 4,000 rules detailed in his greatest work, the Aṣṭādhyāyī, which is thought to have been written around 500 BC -- is meant to work like a machine. Often, two or more of Pāṇini's rules are simultaneously applicable at the same step leaving scholars to agonise over which one to choose. Rajpopat found that between rules applicable to the left and right sides of a word respectively, Pāṇini wanted us to choose the rule applicable to the right side. Employing this interpretation, Rajpopat found Pāṇini's language machine produced grammatically correct words with almost no exceptions. A major implication of Dr Rajpopat's discovery is that now we have the algorithm that runs Pāṇini's grammar, we could potentially teach this grammar to computers.

Antimicrobial Air Filtration Technology can Mitigate Air-borne Infection

A research team at Indian Institute of Science, Bengaluru (IISc), Bangalore, developed germ-destroying air filters that can inactivate germs using ingredients like polyphenols and polycationic polymers commonly found in green tea. These ‘green’ ingredients rupture the microbes through site-specific binding. The novel antimicrobial air filters were tested at the NABL Accredited Laboratory and were found to deactivate SARS-CoV-2 (delta variant) with an efficiency of 99.24 per cent. This technology was transferred to AIRTH, a startup that is replacing the existing germ-growing air filters with germ-destroying air filters for commercialization. This innovation holds promise to develop antimicrobial filters that can prevent epidemics caused by air-borne pathogens, a patent was granted in 2022. These novel antimicrobial filters in our ACs, central ducts and air purifiers can play a crucial role in our fight against air pollution and mitigate the spread of air-borne pathogens like coronaviruses.

Improved Low-cost Magnets for EV Vehicles

Scientists from the Centre for Automotive Energy Materials at the International Advanced Research Centre for Powder Metallurgy & New Materials (ARCI) have fabricated improved low-cost heavy rare earth-free high Nd-Fe-B magnets, which are in high demand for Electric Vehicles and can make them more affordable. They enhanced the coercivity of Niobium (Nb)-containing Nd-Fe-B melt-spun ribbon by grain boundary diffusion process (GBDP) using a low melting point alloy of $Nd_{70}Cu_{30}$ which acts as the source for the “non-magnetic” element. They have reported restricted grain growth during grain boundary diffusion due to the precipitation of Nb, which facilitates the enrichment of Copper (Cu) at the grain boundaries aiding the

increased resistance to demagnetization of Nd-Fe-B powders. The coercivity value of 1 T at 150 degrees C critical for automotive applications achieved in this research could be a useful strategy to develop magnets without Dy for EV applications. ARCI has ventured into setting up a pilot plant for manufacturing of near net shaped Nd-Fe-B magnets. The new strategy could also be used for commercial production of Nd-Fe-B magnets in India, reducing imports that meet the major requirements of the automotive sector.

Artificial Nanostructures for Infrared Absorption Technologies

Researchers in Bengaluru's Jawaharlal Nehru Centre for Advanced Scientific Research (JNCASR) have shown for the first time infrared light emission and absorption with GaN nanstructures. Though blue light emission from GaN has been known, and it is used in LEDs, this is the first time that infrared light-matter interactions are demonstrated in GaN. For this demonstration, they have utilized a scientific phenomenon called surface polariton excitations in GaN nanostructures that lead to light-matter interactions at IR spectral range. The new method which can confine and absorb infrared (IR) light with GaN nanostructures can help develop highly efficient infrared absorbers, emitters, and modulators that are useful in defense technologies, energy technologies, imaging, sensing. Researchers utilized a specialized material deposition instrument called molecular beam epitaxy. This instrument uses ultra-high vacuum, similar to conditions of outer space, to grow high-quality material nanostructures with dimensions about 100000 times smaller than the width of a human hair. Such cross-cutting materials allow the creation of polariton-based devices. Polaritonic technologies have attracted a wide range of applications, such as secure high-speed light -based communication (LiFi), next generation light sources, solar energy converters, quantum computers and waster heat converters.

Organic Solar Cells can Convert Energy-producing Device

Researchers at IIT Kanpur have developed organic solar cell devices consisting of a blend of organic polymer PTB7 as a donor and PCBM as an acceptor. The devices were fabricated on opaque steel substrates with a MoO_3/Au/MoO_3 top electrode. The organic solar cells consisting of a combination of an organic polymer and PCBM (an organic semiconductor) developed on steel substrates can potentially convert a steel roof into an energy-producing device with greater efficiency than those currently available in the market. The potential of third-generation solar cell technologies lies in their integration with flexible and conformal surfaces. However, this integration requires developing new top transparent conducting electrodes as alternatives to indium tin oxide, an optoelectronic material currently in use and poses limitations because of its brittleness and as its optoelectronic efficiency varies with temperature. The devices with multilayer electrodes showed a clear improvement in the photovoltaic performance by 1.5 times, as compared with those obtained with single-layer top metal electrodes of gold.

IN BRIEF

Wearable Skin Patch Monitors Hemoglobin in Deep Tissues

A team of engineers at the University of California San Diego has developed an electronic patch that can monitor biomolecules in deep tissues, including hemoglobin. This gives medical professionals unprecedented access to crucial information that could help spot life-threatening conditions such as malignant tumors, organ dysfunction, cerebral or gut hemorrhages and more. The new, flexible, low form-factor wearable patch comfortably attaches to the skin, allowing

for noninvasive long-term monitoring. It can perform three-dimensional mapping of hemoglobin with a submillimeter spatial resolution in deep tissues, down to centimeters below the skin, versus other wearable electrochemical devices that only sense the biomolecules on the skin surface. It can achieve high contrast to other tissues. Due to its optical selectivity, it can expand the range of detectable molecules, integrating different laser diodes with different wavelengths, along with its potential clinical applications. The patch is equipped with arrays of laser diodes and piezoelectric transducers in its soft silicone polymer matrix. Laser diodes emit pulsed lasers into the tissues. Biomolecules in the tissue absorb the optical energy and radiate acoustic waves into surrounding media. The team plans to further develop the device, including shrinking the backend controlling system to a portable-sized device for laser diode driving and data acquisition, greatly expanding its flexibility and potential clinical utility. They also plan to explore the wearables' potential for core temperature monitoring.

IISc Develops Technology to Generate Hydrogen from Biomass

A team of Indian Institute of Science (IISc) researchers has created a new technology for producing hydrogen from biomass. The procedure is divided into two steps. In the first step, a novel oxygen and steam reactor convert biomass into syngas - a hydrogen-rich fuel gas mixture. The second step involves producing pure hydrogen from syngas using an indigenously developed low-pressure gas separation unit. Both technologies ensure that this process is a highly efficient method of producing green hydrogen, producing 100 g of hydrogen from 1 kg of biomass even though only 60 g of hydrogen is present in 1 kg of biomass. This is because steam, which also contains hydrogen, participates in both homogeneous and heterogeneous reactions in this process (in homogeneous reactions, reactants are in a single phase, whereas, in heterogeneous reactions, the reactants are in two or more phases). This method of producing green hydrogen is also environmentally friendly because it is carbon negative. Solid carbon, which serves as a carbon sink, and carbon dioxide, which can be used in other value-added products, are the two carbon-based byproducts.

RESOURCES & EVENTS

IISc Bengaluru is Secretariat for S20 Working Group on Science

The Indian Institute of Science (IISc), Bengaluru, will function as the secretariat for Science 20 (S20), a working group set up as part of the G20 which will be presided over by India in 2023. S20 has been set up as part of efforts by G20 to address global challenges including climate change mitigation and sustainable development. The theme of S20 for 2023 will be 'Disruptive Science for Innovative and Sustainable Development', the IISc said. The deliberations within this broad theme will focus on three sets of issues – universal holistic health, clean energy for a greener future, and connecting science to society and culture.

SCIENCE POLICY AND DIPLOMACY

UN Biodiversity Conference Takes Steps to Preserve Biodiversity

The second part of the UN Biodiversity Conference convened from 7-19 December 2022 in Montreal, Canada, under the presidency of China, and included concurrent meetings of the governing bodies of the Convention and its Protocols: the 15th meeting of the Conference of the Parties to the Convention (COP15), the tenth meeting of the Conference of the Parties serving as the Meeting of the Parties (MOP 10) to the Cartagena Protocol on Biosafety, and the fourth

meeting of the Conference of the Parties serving as the Meeting of the Parties (MOP 4) to the Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits arising from their Utilization. Approximately 16,000 participants attended the session and parallel events. Approximately 25 per cent of species in assessed animal and plant groups are threatened, and the global rate of species extinction is at least tens to hundreds of times higher than over the past 10 million years. Apart from the food and fibre it provides, biodiversity contributes to the overall well-being of people through economic opportunities and leisure activities. The main drivers of the unprecedented biodiversity loss are changes in land and sea use, direct exploitation of organisms, climate change, pollution, and invasive alien species. Against this grim background, the meeting adopted the Kunming-Montreal Global Biodiversity Framework (GBF) will guide biodiversity policy in the years to come, through four overarching goals and a set of targets to be achieved by 2030. Its implementation is to be facilitated by decisions on resource mobilization and on capacity building and technical and scientific cooperation aiming to address the finance and capacity gaps between the developed and the developing world. A monitoring framework, and a decision on mechanisms for planning, monitoring, reporting, and review, are expected to promote and strengthen implementation and compliance. A decision on benefit-sharing from the use of digital sequence information (DSI) on genetic resources aims to ensure that the CBD framework adapts to technological developments and ensures respect for the Convention's third objective: fair and equitable benefit-sharing.

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