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SCIENCE & TECHNOLOGY

GLOBAL

[Highly Effective Vaccine Against Resistant Infections](#)

A USC team has developed a vaccine, which when given to patients just before or after arriving at the hospital, could protect them against lethal superbugs that lurk in healthcare settings. A new study shows that a single dose, administered in mouse models, put immune cells into active mode, providing rapid protection against eight different bacteria and fungi species. A patent has been filed for the vaccine and a startup set up. The experimental vaccine takes an entirely different approach: It boosts the body's pre-existing supply of pathogen-gobbling immune cells called macrophages, which engulf and digest bacteria, fungi and other bad actors. These activated cells, found in all tissues, quickly neutralize incoming invaders which might otherwise multiply rapidly and overwhelm the body's defenses. The vaccine consists of just three ingredients, two of which are already used in FDA-approved vaccines. A third component is a tiny piece from the surface of a fungus commonly found on human skin.

[Eyedrops Could Treat Macular Degeneration](#)

University of Illinois Chicago researchers have found a small-molecule inhibitor can reverse damage from Wet age-related macular degeneration (AMD) and promote regenerative and healing processes. The drug can also be delivered via eye drops -- an improvement over current treatments for AMD, which require repeated injections into the eye. The compound targets a protein called End Binding-3 in endothelial cells, which line the inside of blood vessels. In the new study, the researchers looked at whether inhibiting EB3 function could stop the damaging leakage associated with wet AMD. Using computational drug design methods, the team developed a small inhibitor that could be delivered externally via eye drops instead of by injection. They then tested its effectiveness in animal models of wet AMD, finding that twice-daily treatment reduced eye damage within 2 to 3 weeks. The team found that the EB3 inhibitor reversed these epigenetic age related changes, restoring gene expression to a normal, healthy state. Because blood vessel leakage and hypoxic stress also drive many other medical conditions, the inhibitor could be relevant for other conditions such as acute lung injury, diabetic retinopathy, stroke, heart disease and even the general effects of aging on the brain. They're also exploring whether an implantable lens, similar to a contact lens, could deliver the drug to the eye more effectively than eye drops.

[Electronic Sensor the Size of a Single Molecule](#)

Australian researchers have developed a piezoresistor that is about 500,000 times smaller than the width of a human hair, which transforms force or pressure to an electrical signal and is used in many everyday applications. The new piezoresistor was made from a single bullvalene molecule that when mechanically strained reacts to form a new molecule of different shape, altering electricity flow by changing resistance. The different chemical forms are known as isomers, and this is the first time that reactions between them have been used to develop piezoresistors. The new feature is the ability to electrically detect the change in the shape of a reacting molecule, back and forth, at about once every 1 millisecond. Detecting molecular shapes from their electrical conductance is a whole new concept of chemical sensing. Understanding the relationship between molecular shape and conductivity will allow basic properties of junctions between molecules and attached metallic conductors to be determined. This new capability is critical to the future development of all molecular electronics devices. Piezoresistors are used to detect vibrations in electronics and automobiles, medical devices, as well as in aviation and space travel. This new type of piezoresistor could open up a whole new realm of opportunities for chemical and biosensors, human-machine interfaces, and health monitoring devices. As they are molecular-based, these new sensors can be used to detect other chemicals or biomolecules like proteins and enzymes, which could be game-changing for detecting diseases.

Making Low-carbon Methanol

Researchers in China have found a new way to make methanol using a novel catalyst that enables the direct conversion of methane to methanol at room temperature with fewer by-products than previous methods. Methanol is widely used in the production of fuels, plastics, and medicines. The researchers constructed active reaction sites on the surface of MoS₂, a two-dimensional material. The modified Mo atoms could then break down oxygen molecules at room temperature to form highly reactive molybdenum-oxygen clusters, which in turn react directly with methane. The innovative catalytic system achieves direct oxidation with a remarkable conversion rate of 4.2 per cent at room temperature. Furthermore, the reaction generates few by-products, and product selectivity exceeds 99 per cent. As an important chemical intermediate, methanol is used to produce formaldehyde, dimethyl ether and acetic acid. As a cleaner source of energy, methanol is also gaining attention as a marine fuel for the shipping industry.

Ultrasound Liver Cancer Treatment Approved by FDA

University of Michigan researchers have developed a method of using sound waves to break down tumors—a technique called histotripsy—in humans for liver treatment. This provides a noninvasive alternative to surgery, chemotherapy and radiation treatments for cancer. The U.S. Food and Drug Administration has approved this treatment. Histotripsy works by using targeted ultrasound waves to form microbubbles within the tumor. The forces created as those bubbles form and collapse cause the mass to break apart, killing tumor cells and leaving the debris to be cleaned up by the immune system. The treatment avoids radiation or chemotherapy, and has far shorter recovery times than with surgery and less treatment discomfort. It is much easier to ensure that histotripsy treatments are hitting the tumor, and not healthy tissue, compared to radiation or invasive procedures. The histotripsy system has onboard diagnostic ultrasound imaging, enabling planning and observing the treatment in real time. Physicians have a live view of the “bubble cloud” and how tissue is responding to the therapy. And histotripsy’s potential benefits go beyond tumor destruction. In the last year, a pair of preclinical studies in rodents suggest that in the clean-up process, the immune system learns how to identify cancer cells as threats. This can

enable the body to continue fighting the initial tumor and help activate a natural immune response to the cancer. A study showed that histotripsy breaks down the cancer cell wall's boundary—revealing proteins that the immune system can use to identify threats, known as antigens for the immune system to identify and use for targeted attacks on other cancer cells. The researchers are working to develop histotripsy to treat tumors globally all over the body and eventually into a cure.

INDIA

Breakthrough in Fabrication of High Energy Density Capacitors

Researchers at the Centre for Nano and Soft Matter Sciences, Bengaluru, have synthesised highly crystalline pyrite FeS₂ at low temperatures and utilized them for fabricating electrochemical energy storage devices such as batteries and high energy density supercapacitors (SCs). They demonstrated the low-temperature synthesis of crystalline pyrite FeS₂ through a solid-state synthesis route. They have utilized a metastable oxyhydroxide (FeOOH) precursor for this process. The team reported stabilising this intermediate oxyhydroxide and utilizing it as a precursor for sulfidation, in the presence of H₂S gas, for the first time. The FeS₂ electrode exhibited high energy and power densities, clearly highlighting the role of the synthetic procedure employed for enhancing electrochemical properties.

IISER Bhopal Identifies Circular RNA Crucial to Hinder HIV-1 Virus Replication

Researchers from the Indian Institute of Science Education and Research Bhopal (IISER Bhopal) identified a specific circular RNA (circRNA) called 'ciTRAN', which plays a crucial role in multiplication of the AIDS-causing HIV-1 virus within the human body. The researchers developed a novel approach called 'circDR-Seq', to successfully capture circRNAs from T-cells (white blood cells) infected with the HIV-1 virus and identified a specific circRNA named ciTRAN, which plays an important role in the multiplication of the virus. The results indicated that HIV-1 virus hijacks this host-encoded ciTRAN in such a way that it can use it to multiply efficiently. This discovery uncovered a previously unknown aspect of how viruses like HIV-1 overcome transmission barriers. Researchers also developed a small protein molecule that can inhibit viral transcription, in the context of virally-induced ciTRAN. By showing how ciTRAN promotes the virus's ability to multiply efficiently, this study offers promising avenues for the development of novel therapeutic interventions.

Nano-sized Enzyme Breaks Down Toxic Effluents

A team of Indian Institute of Science (IISc) scientists has developed an enzyme mimetic capable of degrading toxic chemicals in industrial wastewater in the presence of sunlight. They can address limitations in the mass production of enzymes. Nanozymes can mimic such natural enzymes and overcome these practical challenges. The team synthesised NanoPtA, a platinum-containing nanozyme that can be converted into powder form for industrial use. NanoPtA mimics the function of oxidases (natural enzymes that remove hydrogen from substrates in the presence of oxygen to give water). It can degrade pollutants in wastewater by oxidising them in sunlight, thereby reducing the toxicity of the wastewater. Tests on common effluents that pollute water validated the nanozyme's ability to degrade even small (micromolar) quantities of phenols and dyes within 10 minutes, when placed in sunlight. The researchers found that the NanoPtA complex could last up to 75 days at room temperature.

Tata and IISc to Steer Cybersecurity Solution for Vehicles

Tata Elxsi will collaborate with the Indian Institute of Science (IISc) to develop an automotive cybersecurity solution. The collaboration, formalised as part of an existing MoU, is aimed at overcoming cybersecurity challenges that emerge from complex in-vehicle networks of sensors and various software applications. IISc noted that the advances made in vehicle-to-vehicle and vehicle-to-anything (V2X) connectivity have presented more opportunities for theft, remote control, tampering, and siphoning of personal information.

Breakthrough on Secure Quantum Communication

IIT-Delhi researchers have achieved an experimental breakthrough on secure quantum communication up to a distance of 380 kilometres in standard telecom fiber with a very low error rate that can be helpful in securing financial transactions and secret codes. The low quantum bit error rate (QBER) makes the quantum communication resistance to collective and individual attacks and implementable for various applications, such as securing financial transactions, medical records and secret codes. It is also capable of securing network communication such as Internet of Things (IoT) and ready to revolutionise the field of cyber security. This QKD demonstration shows methods to get rid of the intermediate trusted nodes, which are the weak security loopholes and are vulnerable to several kinds of attacks. It paves ways for more secure long distance communication useful for strategic areas such as defence and online banking, making digital transactions safer in the near future.

Green Hydrogen Production Technology

A team led by Banaras Hindu University Varanasi has developed a next-generation quantum-powered photo-catalyst for producing green hydrogen. The photochemical-reactor design maximizes the capture of solar energy. The team has engineered a continuous electron coupled proton supply system, propelled with an electron injector mechanism utilizing industrial metal-waste, and after rigorous optimizations, the peak rate of Green Hydrogen production at lab scale was achieved to be about 1 litre/min per 10 g of the photocatalyst. Due to the high purity of the hydrogen gas produced, the fuel can be used without additional purification, thus enhancing the cost-effectiveness of the technology. This transformative innovation would offer wide ranging application possibilities across various sectors ranging from energy production to applications in transportation and agriculture. A patent has been filed for this technology.

Novel Method to Improve Properties of Drug Molecules

IISc has discovered a novel method for improving the pharmacokinetic properties of “macrocyclic peptides” – drug molecules that are pursued heavily by pharmaceutical industries worldwide. The IISc team, in collaboration with Anthem Biosciences, has demonstrated that substituting just a single atom – oxygen with sulphur – in the backbone of a macrocyclic peptide can make it more resistant to digestive enzymes, and can increase its permeability through cell membranes, boosting its bioavailability.

Sponge-like Material to Capture Iodine for Lithium Batteries Developed

Indian Institute of Science Education and Research (IISER) Pune has developed a material to capture hazardous iodine waste which can be used in lithium-ion batteries. The team developed a sponge-like covalent-organic framework made of complex bonds of carbon, hydrogen, and

oxygen that helps capture and store iodine in stable conditions from vapour or aqueous mediums. The iodine-captured material acted as an excellent cathode material in the battery, opening up the possibility of using iodine waste in battery applications. It mitigates the negative impact on the environment by removing hazardous iodine and can be used in clean energy applications.

G-20 AND GLOBAL CHALLENGES

India-Middle East-Europe Economic Corridor Discussed

External Affairs Minister S. Jaishankar and US Secretary of State Antony Blinken engaged in discussions regarding the India-Middle East-Europe Economic Corridor. Discussions covered a full range of issues, including key outcomes of India's G20 presidency, and the creation of the India-Middle East-Europe Economic Corridor and its potential to generate transparent, sustainable, and high-standard infrastructure investments. They underscored the ongoing importance of collaboration in preparation for the upcoming 2+2 Dialogue, with a specific focus on defense, space, and clean energy sectors. At the G20 Summit held in India, India, the United States, UAE, Saudi Arabia, France, Germany, Italy, and the European Union inked a Memorandum of Understanding (MoU) to establish the India-Middle East-Europe Economic Corridor. Also discussed was the India-US Initiative on Critical and Emerging Technology (iCET) which seeks to elevate and expand the strategic technology partnership and defense industrial cooperation between the two countries.

IN BRIEF

Nasal Vaccine against Strep A

Researchers from Griffith University have developed a Streptococcus A vaccine which is currently in Phase 1 clinical trials in Canada and quickly advancing to Phase 2 efficacy trials. They found that an experimental liposome-based vaccine approach incorporating a part from Strep A and an immunostimulatory glycolipid PHAD administered via the nasal passage, can provide long-term mucosal protection against Strep A. This has the potential to be a world-first as there are currently no subunit vaccines that target the upper respiratory tract due to a lack of licenced immunostimulants suitable for human use. The team found that PHAD plays an augmenting role in inducing enduring humoral and cellular immunity, which was evident for at least one-year post-vaccination. In the future, this vaccine platform could pave the way for other mucosal pathogens and could open up a new direction for vaccines against significant infectious pathogens that cause serious and life-threatening diseases. Strep A causes 700 million human infections each year and there are more than 500,000 deaths globally.

New Method Makes Valuable Organic Acid from Plants

In a breakthrough for environmentally friendly chemical production, US researchers have created a cost-effective, end-to-end method for making succinic acid, an important industrial chemical, from sugarcane, by engineering a tough, acid-tolerant yeast as the fermenting agent, avoiding costly steps in downstream processing. Succinic acid is a widely used additive for food and beverages and has diverse applications in agricultural and pharmaceutical products. This same method can be used to produce other industrially important organic acids. The team used *Issatchenkia orientalis*, an unconventional yeast ideal for making organic acids. This organism lives can function at a pH of 3 to 4. The team engineered *I. orientalis* to produce robust levels of

succinic acid, adding an enzyme was added that could break down sucrose from the sugarcane juice into glucose and fructose to make succinic acid. Other genes were introduced to overproduce succinic acid. The team scaled up succinic acid production using industrially relevant equipment and showed the new strains could produce up to 110 g/L of succinic acid and, after batch fermentation and downstream processing, an overall yield of 64 per cent.

Metal-loving Microbes for Processing of Rare Earths

Cornell University scientists have characterized the genome of a metal-loving bacteria *S. oneidensis* with an affinity for rare earth elements. The research paves the way towards replacing the harsh chemical processing of these elements with a benign practice called biosorption. The microbe selectively adsorbs - or clings - to these rare earth elements, making it an ideal candidate to carry out an eco-friendly purification procedure. Generally, *S. oneidensis* prefers dining on the f-block elements residing in the sixth row of the periodic table, known as the lanthanides. Specifically, the microbe favors europium. Characterizing the *S. oneidensis*'s genome allows scientists to tweak its preference for processing the other rare earth elements. This work has the potential to make processing rare earths cleaner and scalable. The group anticipates creating a pilot-scale purification system by 2028.

Perovskite-silicon tandem PV cell hits record efficiency of 25.1%

US scientists have developed a perovskite-silicon tandem solar cell with a steady-state power conversion efficiency of 25.1%. The scientists built the 24 cm² tandem cell with a lithium fluoride (LF) interlayer placed at the interface between a hole transport layer (HTL) made of poly-triarylamine (PTAA) and a wide bandgap (WBG) perovskite absorber. This interlayer is the key element that reportedly improves physical contact at the buried interface and mitigates shunting. They deposited the PTAA and WBG perovskite layers through blade coating. The researchers deposited the other layers of the tandem cell by sputtering, thermal evaporation, and atomic layer deposition (ALD). Tested under standard illumination conditions, the 24 cm² tandem cell showed an efficiency of 25.2%, an open-circuit voltage of 1.89 V, a short-circuit current density of 18.1 mA/cm² and a fill factor of 0.736.

RESOURCES & EVENTS

World Health Organization Endorses Second Malaria Vaccine

The World Health Organization (WHO) today recommended widespread use of a second vaccine against malaria, called R21/Matrix-M, after the first malaria vaccine, called Mosquirix or RTS,S, for which WHO made a similar recommendation 2 years ago. That vaccine, however, is in short supply, with only about 18 million doses expected to be available through 2025. The addition of a second vaccine is expected to close the gap between supply and demand, and has the potential to save tens of thousands of lives each year. Both vaccines contain a protein from the surface of the parasite that causes the deadliest form of malaria, *Plasmodium falciparum*. The latest encouraging data from a phase 3 trial of R21 involving 4800 children was considered by a WHO expert group. R21, which was developed at the University of Oxford, still needs to complete WHO's so-called prequalification process, which looks not only at safety and efficacy, but also manufacturing practices and quality control. That process is underway and should be complete in the near future. Once the vaccine receives prequalification, it will be eligible for purchase by

groups such as UNICEF and Gavi, the Vaccine Alliance, which buy vaccines for distribution in many low-income countries. R21 could be widely available for use in the second half of 2024. At least 28 countries have drawn up plans to introduce vaccines as part of their malaria control programs. Both vaccines require three initial doses within several months, plus a fourth dose 12 months later, and will likely require additional boosters to maintain high levels of protection. The Serum Institute of India, one of the world's largest vaccine makers, is cooperating with Oxford to develop the vaccine and has said it will be able to produce 100 million doses per year starting as soon as next year.

New Global Framework for the Integrated Management of Chemicals and Waste

The International Conference on Chemicals Management 5th session, 25-29 September in Bonn (ICCM5) formally adopted a new global framework for the integrated management of chemicals and waste beyond 2020, the 'Global Framework on Chemicals – For a planet free of harm from chemicals and waste.' The Conference also adopted the Bonn Declaration, a political statement. Based around 28 targets, the Global Framework outlines a roadmap for countries and stakeholders to collaboratively address the lifecycle of chemicals, including products and waste. The 12-part Framework, its three annexes, and the accompanying 12 resolutions cover issues as: phasing out the most harmful chemicals; strengthening capacity building, particularly for countries with weak enforcement regimes; and creating better linkages across diverse sectors, including health and occupational safety, trade, agriculture, energy, and transport. The negotiating process was unique in that representatives from governments, the private sector, non-governmental and intergovernmental organizations, youth, and academia participated at the same level. The Global Framework, inter alia, calls for preventing the illegal trade and trafficking of chemicals and waste, implementing national legal frameworks, and phasing out by 2035 of highly hazardous pesticides (HHPs) in agriculture. It also calls for transitioning to safer and more sustainable chemical alternatives, responsibly managing chemicals in various sectors – including industry, agriculture, and healthcare – and enhancing transparency of and access to information regarding chemicals and their associated risks. In addition, ICCM5 launched a Global Alliance on Highly Hazardous Pesticides, as well as a process for creating implementation programmes for the new Framework that should result in new sector-focused initiatives involving key heavy users of chemicals, such as the textile and construction sectors.

Adani Commissions 150 MW Solar Project

Adani Solar Energy Jaisalmer Two Private Limited, a wholly-owned stepdown subsidiary of Adani Green Energy Limited (AGEL) has progressively completed the commissioning of the entire 150 MW solar power project at Bikaner, Rajasthan as an Independent Power Producer (IPP) for sale of power to third parties or on power exchanges. The firm has a series of large-size projects in Rajasthan and its interest has only been growing in the region. With the successful commissioning of the said plant, AGEL's total operational renewable generation capacity has increased to 8,404 MW. This places AGEL's total renewable portfolio well on track to reach its vision of 45 GW capacity by 2030. Adani Green Energy recently commissioned a 2 GW solar cell and module factory under a manufacturing-linked tender by Solar Energy Corp. of India (SECI). The plant is located in Mundra, Gujarat. Adani Green Energy secured 8 GW of solar projects under the manufacturing-linked PV tender, contingent on establishing 2 GW of PV cell and module manufacturing capacity.

SCIENCE POLICY AND DIPLOMACY

Visit of the President of Tanzania Strengthens Relations

Discussions during the 3 day visit of the President of Tanzania covered cooperation in fields such as Blue economy, space technologies and digital public infrastructure under India Stack including Unified Payments Interface (UPI) and Digital Unique Identity (Aadhar). Both sides welcomed the setting up of the first overseas campus of the Indian Institute of Technology (IIT), Madras in Zanzibar with classes for the first batch scheduled to begin shortly. Both sides agreed to work for further collaboration in the health sector. The Indian side welcomed Tanzania's decision to join the International Big Cat Alliance (IBCA) and the Global Biofuel Alliance (GBA) and looked forward to Tanzania's membership of the Coalition for Disaster Resilient Infrastructure (CDRI).

Internet Governance Forum meeting, Kyoto 8-12 October

The Internet Governance Forum, 8-12 October 2023, Kyoto, brought together close to 9,000 registered participants, from 178 countries (92% of UN Member States). The umbrella theme was 'The Internet We Want – Empowering All People' with eight sub-themes: (1) AI & Emerging Technologies; (2) Avoiding Internet Fragmentation; (3) Cybersecurity, Cybercrime & Online Safety; (4) Data Governance & Trust; (5) Digital Divides & Inclusion; (6) Global Digital Governance & Cooperation; (7) Human Rights & Freedoms; and (8) Sustainability & Environment. Key issues discussed included the acceleration in artificial intelligence (AI) beyond generative AI, and the need for action to mitigate the risks, while maximizing its promise. Other important themes covered included data governance; cybersecurity; and the environment. The IGF deliberations will feed into the **Global Digital Compact**, part of the UN's Summit of the Future in 2024; and the 20-year review of the **World Summit on the Information Society (WSIS+20) in 2025**. A vision paper on 'The Internet We Want' was presented. The Government of Japan also announced their plans at the Forum for an Artificial Intelligence accord that would see G7 nations agree on international guidelines and codes of conduct for the developers of generative AI. The [draft document containing the summary of key points discussed at the Forum](#) is available for public comments.

We welcome your comments and valuable suggestions. Please write to us for receiving publications, updates and notices regarding seminars, conferences etc. Contact us at science.diplomacy@ris.org.in

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