



SCIENCE &

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PULSE

MONTHLY NEWSLETTER

Navigating the World of Science and Innovation





Shaping the Future of Photonics: IISc's Innovation in Nanoscale Light Manipulation

This technology has significant implications for the telecommunications, cybersecurity, and semiconductor industries, offering enhanced quantum cryptography systems and more efficient photonic chips for secure data transmission.

Researchers at IISc Bangalore have developed a platform that integrates 2D semiconductor colloidal quantum wells (CQWs) with dielectric meta surface resonators (MSRs) to control light at the nanoscale. This integration led to a 12-fold increase in brightness and a 97% reduction in spectral line width, achieving high spectral purity and long-range photon transport of up to 1 mm on a chip.

The study, published in *Advanced Optical Materials*, could revolutionize quantum communication and photonic device applications. Future developments aim to incorporate single-photon emitters for secure communication and advanced sensing technologies.

In this newsletter you can expect updates from:

Emerging Technologies

Government Initiatives

Food and Agriculture

Environmental Science

Health and Medicine

Space Exploration



Copper-Based Nano Catalyst Paves Way for Sustainable Industrial Processes

This innovation benefits pharmaceuticals, materials science, and environmental remediation by providing cost-effective, eco-friendly alternatives to conventional catalysis. It enhances wastewater treatment, fine chemical production, and nanoscale electronics.

Scientists at the Institute of Nano Science and Technology (INST), under the Department of Science and Technology (DST), have developed a sustainable copper-based nano catalyst with a unique star-like structure. This catalyst, formed by growing copper oxide nanostructures on a sporopollenin template, offers high efficiency in organic reactions under environmentally friendly conditions without additives. It surpasses conventional catalysts in performance, requires no harsh solvents, and is reusable across multiple cycles. Published in *Nanoscale* 2024, the innovation aligns with sustainability goals by utilizing biomass waste and transforming it into valuable catalysts.



Government Extends Special Package for DAP Fertilizer

This policy supports fertilizer manufacturers, importers, and logistics companies by stabilizing demand and ensuring steady government contracts, thus strengthening India's agri-supply chain ecosystem.

Researchers at INST Mohali have developed a nano-formulated melatonin using human serum albumin nanocarriers that significantly enhances its bioavailability and neuroprotective effects in Parkinson's disease. This innovative system allows for sustained release of melatonin to the brain, thereby boosting antioxidative mechanisms such as mitophagy and mitochondrial biogenesis, which are essential for combating oxidative stress. The nano-formulation not only protects dopamine-producing neurons from pesticide-induced toxicity but also regulates BMI1, a critical epigenetic factor linked to oxidative stress reduction. Additionally, the use of HSA nanocarriers overcomes traditional bioavailability challenges, offering a more targeted and sustained therapeutic approach.



Enhanced PMFBY & RWBCIS with Technology Boost for Farmers & Industries

These advancements will benefit agriculture technology providers, weather data firms, and insurance industries by fostering partnerships for precision farming and data-driven insurance models.

The Union Cabinet approved the continuation of Pradhan Mantri Fasal Bima Yojana (PMFBY) and Restructured Weather-Based Crop Insurance Scheme (RWBCIS) till 2025-26 with an allocation of ₹69,515.71 crore. Key additions include the Fund for Innovation and Technology (₹824.77 crore) for initiatives like YES-TECH, which uses remote sensing for yield estimation, and WINDS, a hyperlocal weather data system. WINDS will deploy automatic weather stations and rain gauges at granular levels, improving transparency and reducing claim settlement delays. These advancements aim to enhance risk assessment and ensure faster financial relief for farmers.



Government Hikes Jute MSP to Support Farmers and Boost Industry

The higher MSP strengthens the jute, packaging, and textile industries, enabling steady raw material supply for eco-friendly packaging, aligning with sustainable goals, and encouraging innovation in jute-based products.

The Cabinet Committee on Economic Affairs has approved the Minimum Support Price (MSP) of raw jute (TD-3 grade) at ₹5,650 per quintal for the 2025–26 marketing season, ensuring a 66.8% return over the all-India weighted average production cost. This marks a ₹315 increase from the previous year and a 2.35-fold rise since 2014-15. With 40 lakh farm families and 4 lakh mill workers dependent on the jute industry, this decision benefits 82% of West Bengal's farmers, alongside those in Assam and Bihar. The Jute Corporation of India will manage price support operations, with losses reimbursed by the Central Government.



Breakthrough in Nitrogen Use Efficiency Promises Sustainable Agricultural Growth

This innovation can benefit agriculture, agrochemical, and biotechnology industries, providing eco-friendly alternatives to nitrogen fertilizers, reducing operational costs, and enhancing crop yields sustainably.

Researchers at the National Institute of Plant Genome Research (NIPGR) have discovered that reducing nitric oxide (NO) levels in plants can significantly improve nitrogen uptake and Nitrogen Use Efficiency (NUE) in rice and Arabidopsis. By modulating NO levels through genetic and pharmacological methods, such as overexpressing phytohemoglobin (a natural NO scavenger) and using chemical treatments like SNAP and cPTIO, they enhanced high-affinity nitrate transporter (HAT) activity, leading to better nitrogen absorption and plant growth. Unlike conventional nitrogen fertilizers, this approach is cost-effective, environmentally friendly, and reduces harmful NO_x emissions. The study, supported by ANRF, paves the way for sustainable agriculture with lower fertilizer dependency and offers potential for bacterial-based NO scavenger solutions.

Unveiling Microbes That Influence Climate Through Amazon Peatlands

This discovery is vital for the environmental management, agriculture, and energy industries, providing insights into carbon sequestration strategies and ecosystem sustainability. Industries can leverage these findings to develop carbon credit programs, enhance land management policies, and invest in sustainable development to mitigate climate risks.

Scientists from Arizona State University and the National University of the Peruvian Amazon have discovered a new family of microbes thriving in the waterlogged, low-oxygen peatlands of the Amazon rainforest. These microbes play a critical role in carbon cycling, either storing carbon for long-term climate stability or releasing it as greenhouse gases like CO₂ and methane. Tropical peatlands store an estimated 3.1 billion tons of carbon, double that of global forests. However, environmental changes such as deforestation and climate shifts could release 500 million tons of carbon by 2100, equivalent to 5% of annual fossil fuel emissions. The microbes, part of the Bathyarchaeia group, metabolize carbon monoxide and contribute to methane production, showcasing their adaptability to fluctuating conditions. Protecting these ecosystems is crucial for maintaining their carbon sink function and preventing further emissions that could exacerbate climate change.



Innovative Peptide-Based Nanoparticles Improve Drug Delivery and Efficacy

This innovation benefits the pharmaceutical and biotechnology industries by enabling more efficient drug delivery, reducing development costs, and improving patient outcomes. It offers potential for precision medicine, enhancing existing drug formulations and expanding the use of previously ineffective compounds.

Researchers at CUNY ASRC and Memorial Sloan Kettering Cancer Center have developed a peptide-based approach to enhance drug formulations, significantly improving anti-tumour efficacy in leukemia models. This method addresses challenges such as poor solubility and inefficient drug delivery by using specially designed peptides to form nanoparticles with up to 98% drug loading. The peptide coating enhances stability, solubility, and targeted delivery, allowing for lower drug doses and reduced side effects. The customizable nature of this approach opens opportunities for a wide range of drugs beyond cancer treatments. The team aims to automate the process and expand applications to other diseases.



HPV16 Therapeutic Vaccine Shows Promise in Treating Precancerous Cervical Lesions

This advancement presents a promising opportunity for the biopharmaceutical and healthcare industries, potentially reducing reliance on surgical interventions and offering cost-effective, less invasive treatments for HPV-related cervical lesions.

A phase II clinical trial has shown that a therapeutic vaccine, Vvax001, targeting HPV16 led to regression in high-grade precancerous cervical lesions in half of the treated patients. Conducted by researchers at University Medical Centre Groningen, the trial involved 18 patients with CIN3 receiving three doses of Vvax001 over three weeks. Results showed that nine patients experienced lesion regression, with three achieving complete remission and six showing low-grade dysplasia. HPV16 clearance was observed in 10 of 16 patients assessed. The vaccine, based on a modified Semliki Forest virus expressing E6 and E7 oncogenic proteins, reduced lesion sizes in nearly all patients within a month post-vaccination. Those whose lesions did not regress underwent surgery, with no residual disease found in four cases. If validated in larger studies, Vvax001 could offer a non-surgical alternative to standard loop excision, minimizing associated risks and complications. The study was supported by the Dutch Cancer Society and ViciniVax.



Nano-Formulated Melatonin Offers Potential for Parkinson's Disease Treatment

This development presents significant opportunities for the pharmaceutical, biotech, and nutraceutical industries, offering an innovative, scalable solution for neurodegenerative diseases with improved treatment efficacy and patient outcomes.

Researchers at INST Mohali have developed a nano-formulated melatonin using human serum albumin nanocarriers that improves its bioavailability and neuroprotective effects in Parkinson's disease. This system provides sustained release to the brain, enhancing antioxidative mechanisms like mitophagy and mitochondrial biogenesis, protecting dopamine neurons, and regulating the epigenetic factor BMI1. The study, published in ACS Applied Materials & Interfaces, points to a promising, safer treatment option for PD and other neurodegenerative disorders.



ISRO's Space Docking Milestone Unlocks New Horizons for Future Space Missions

This achievement will benefit aerospace, satellite manufacturing, and logistics sectors by enabling advanced modular spacecraft designs and fostering international collaborations for space technologies.

India's ISRO achieved a major milestone with the successful completion of the Space Docking Experiment (SpaDeX) using the indigenous Bharatiya Docking System, making India the fourth country globally to accomplish space docking after the US, Russia, and China. Launched on December 30, 2024, SpaDeX saw two spacecraft docked, controlled as a single object, and undocked successfully. This breakthrough paves the way for missions like the Bhartiya Antriksh Station, Chandrayaan 4, and Gaganyaan, boosting India's space exploration ambitions.

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