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FROM THE DG'S DESK

Greetings and best wishes to all our esteemed readers for a productive and inspiring year 2026!

It gives me an immense pleasure to present an overview of the key activities and engagements of the NAM S&T Centre from January to March 2026. This period has been marked by dynamic initiatives, strengthened partnerships and continued commitment to advancing science, technology and innovation across our member countries as well as other developing countries in the Global South.

The Centre has remained actively engaged in promoting dialogue on emerging and critical areas of sustainable development. Notably, an International Workshop on *"Circular Economy in Leather and Leather Product Industries"* was successfully organized in Chennai, India during 29-30 January 2026 in collaboration with the CSIR-Central Leather Research Institute (CLRI), Chennai. The Workshop brought together experts, policymakers and industry stakeholders, culminating in the adoption of the *Chennai Resolution 2026*, which outlines actionable strategies for promoting sustainability and resource efficiency in the leather sector. In addition, the Centre organized an International Workshop on *"Promoting Blue Economy and Overcoming its Implementation Challenges"* during 26-27 March 2026 in Mauritius in collaboration with the Ministry of Tertiary Education, Science and Research, Govt. of Mauritius. The Workshop focused on advancing blue economy and addressing its key implementation challenges. These initiatives reflect our continued focus on addressing global challenges through collaborative and interdisciplinary approaches.

The NAM S&T Centre has also made significant progress in strengthening inter-institutional collaborations. A Memorandum of Understanding (MoU) was signed with the Energy Management Centre (EMC), Ministry of Power, Govt. of Kerala, India; while the MoU with the Indian Ocean Rim Association (IORA) was successfully renewed, reaffirming our shared commitment to advancing cooperation in science and technology.

On the publication front, there is an addition of a new book entitled *"Development of Food Green Cities for Urban Sustainability"*, which addresses sustainable urban food systems and environmental resilience.

Looking ahead, we are delighted to announce an upcoming International event on "*Foundations of Science Diplomacy: A Training Programme for Early and Mid-Career Researchers*", to be held from 21-23 June 2026 in South Africa, which will provide a platform for dialogue and cooperation amongst scientists, policymakers and other stakeholders.

The NAM S&T Centre remains committed to fostering international cooperation, promoting innovation and supporting sustainable development across member and other developing countries.

We extend our sincere appreciation to our Member Countries, Members of NAM S&T – Industry Network, other partners and readers for their continued support and engagement.

Wishing you all a cheerful New Year and Happy Reading!

(Amitava Bandopadhyay)
Director General

Centre Organised

International Workshop on
Circular Economy in Leather and Leather Product Industries
Chennai, India; 29-30 January 2026

Global leather industry encompassing leather, footwear and leather garments, holds a significant position in international trade and manufacturing. The sector plays a crucial role in employment generation, particularly in developing economies where micro, small and medium enterprises (MSMEs) dominate the value chain. Despite its economic importance, the leather industry faces increasing scrutiny due to its environmental footprint. The pre-tanning and tanning stages are particularly associated with high levels of pollution. The generation of hazardous sludge, emissions of volatile organic compounds (VOCs) and the dumping of leather scraps and trimmings further aggravate the ecological challenges associated with this sector.

Inauguration of the International Workshop on "Circular Economy in Leather and Leather Product Industries"

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International Workshop on
Promoting Blue Economy and Overcoming its Implementation Challenges
Mauritius; 26-27 March 2026

Oceans are vital to livelihoods in countries sharing a coastline and benefits obtained are dependent on science-based management of oceanic resources. The concept of the Blue Economy, introduced at the United Nations Conference on Sustainable Development 2012 and as defined by the World Bank, *promotes sustainable use of ocean resources for economic growth, employment and ecosystem protection*. However, over exploitation, limited governance and lack of scientific integration continue to threaten marine ecosystems, especially in

Inauguration of the International Workshop on "Promoting Blue Economy and Overcoming its Implementation Challenges"

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In the leather garment and footwear industries, fast fashion trends have led to shortened product life cycles and increased pressure on natural resources. A growing volume of post-consumer leather waste ends up in landfills or incineration, leading to the loss of valuable material and contributing to carbon emissions. Additionally, leather off-cuts, trimmings and defective products are often discarded without adequate valorization. As global markets and consumers shift towards environmentally safe products and practices, there is a pressing need for the leather and leather product industries to adopt sustainable and circular models. A "Circular Economy" approach seeks to redesign production and consumption systems to keep materials in use for as long as possible, minimize waste and regenerate natural systems.

Considering the importance of the above mentioned issues, the Centre for Science and Technology of the Non-Aligned and Other Developing Countries (NAM S&T Centre), New Delhi, India, jointly with CSIR-Central Leather Research Institute (CLRI), Chennai, India organized an International Workshop on **"*Circular Economy in Leather and Leather Product Industries*"** during 29 - 30 January 2026 in Chennai, India. Additionally, the Leather and Shoe Research Institute (LSI), Hanoi, Vietnam participated as a Scientific Partner, bringing its extensive expertise in sustainable leather processing and footwear manufacturing to support the goals of the Workshop.

The Workshop focused on practical approaches and innovative solutions to promote a *Circular Leather Economy*, emphasizing sustainability, resource efficiency and market competitiveness. The International Workshop was conducted over **2** days which brought together **46** delegates including government officials, industry leaders, researchers and representatives from international organizations and academic institutions, from **9** countries **- Indonesia, Kenya, Malaysia, Nigeria, Palestine, South Africa, Sri Lanka, Vietnam,** and the host country – **India**, reflecting a diverse and global engagement in advancing circularity in the leather sector, and providing a broad spectrum of perspectives on challenges and opportunities for building a competitive, environmentally sustainable leather industry.

Inaugural Ceremony began with the **Welcome Address** by **Dr. P. Thanikaivelan**, Director of CSIR-Central Leather Research Institute (CSIR-CLRI), Chennai, Tamil Nadu, India. In his address, he warmly welcomed the dignitaries, speakers and other participants, and provided an overview of the objectives and significance of the workshop, highlighting the institute's commitment to advancing leather science and technology. This was followed by the **Opening Remarks** delivered by **Dr. Amitava Bandopadhyay**, Director General of the Centre for Science & Technology of the Non-Aligned and Other Developing Countries (NAM S&T Centre), New Delhi, India. He emphasized the importance of international collaborations, knowledge sharing and capacity building among developing nations in the field of science and technology. He highlighted the NAM S&T Centre's longstanding commitment to capacity building and its ongoing efforts to support Member Countries in aligning national priorities with global goals such as the Sustainable Development Goals (SDGs) and Net Zero targets. He also provided an overview of the Centre's numerous international programs and workshops, all designed to foster knowledge exchange and collaborative research.

The workshop was officially inaugurated by the **Chief Guest** – **Mr. P. S. Suresh**, President, Indian Shoe Federation (ISF), Chennai, India. Referring to the Sustainable Development Goals (SDGs) - 2030 framework of the United Nations, he underlined that sustainability is inherently embedded within global developmental aspirations and must form the foundation of industrial and economic growth.

The **Guest of Honour** was **Mr. R. Selvam**, IAS, Executive Director of the Council for Leather Exports (CLE), Chennai, India and in his address,spoke about India's export potential, policy support and global positioning in the leather industry.

Dr. B. Chandrasekaran, President of LERIG Trust, Chennai; and Distinguished Scientist, CSIR-CLRI, Chennai, India, in his address highlighted the role of research, innovation, and industry engagement in strengthening the leather ecosystem. He emphasized the urgent need to develop comprehensive Standard Operating Procedures (SOPs) to strengthen sustainability and circularity practices within the leather sector.

A significant highlight of the session was the Release of the Book titled *"**Emerging Trends in Leather Science and Technology**"*, a joint publication project of CSIR-CLRI and the NAM S&T Centre, published by the reputed International Publisher **Springer Nature, Singapore**.

Release of the Book titled "Emerging Trends in Leather Science and Technology"

It was followed by the **First Copy Release of Workshop Booklet (Abstract Booklet)** by the dignitaries. **Dr. R. Aravindhan**, Scientist F, CSIR-CLRI expressed a deep sense of appreciation to the NAM S&T Centre for co-organising the third International Workshop with CSIR-CLRI.

Two days conference comprised **5 Technical Sessions** including **6 Keynote Lectures**, **2 Knowledge Partner Presentations**, **29 Paper Presentations** and **Networking Opportunities** to encourage dialogue on policy frameworks, technological advancements and industry best practices, along with the adoption of **Chennai Resolution 2026**.

Release of the Workshop Booklet (Abstract Booklet)

The **Technical Session I** on '***National and International Regulations Supporting "Circularity"*** was chaired by **Dr. B. Chandrasekaran [**India], **Technical Session II** on ***Waste Management and Value Recovery*** was chaired by **Dr. Le Tran Vu Anh** [Vietnam] and co-chaired by **Dr. Sri Kameswari**, Scientist-G, CSIR-CLRI [India]. The **Technical Session III** on ***Circularity in Raw Material Sourcing and Processing*** was chaired by **Dr. J. Raghava Rao**, Emeritus Scientist, CSIR-CLRI [India]; **Technical Session IV** on ***Technology and Innovation towards***

Group photo of the International Workshop on "Circular Economy in Leather and Leather Product Industries"

Biodegradable and Bio-based Alternatives, was chaired by **Dr. Eyad Yacoub Ahmed Yaqob** [Palestine] and the last **Technical Session V** on ***Future Aspects for Achieving Circularity in Leather Sector*** was chaired by **Dr. Jerry Tagang** [Nigeria].

The first **Keynote Lecture** was delivered by **Dr. (Mrs.) Rama Swami Bansal**, Chief Scientist & Head, International S&T Affairs Directorate (ISTAD), Council of Scientific and Industrial Research (CSIR), New Delhi [India] on *"Partnerships in S&T in the Global South: Achieving SDGs and Beyond"* during Technical Session I. The Technical session II commenced with a Keynote Address by **Dr. R. Aravindhan** on "*Circular Solutions: Solid Waste Valorization Technologies in the Leather Sector*". **Dr. Umi Karomah Yaumidin**, Head, Center for Behavioral & Circular Economics Research, BRIN [Indonesia] delivered her Keynote address on "*Adopting Circular Economy Standard in Indonesia: Addressing Key Drivers and Barriers in Leather and Footwear Industries*" during Technical Session III. There were two Keynote lectures during Technical Session IV on "*Advancing Circularity in Leather: Industry Pathways for Bio-based and Biodegradable Materials*" by **Mr. Manoj Bhaiya**, President, C&E Limited, Chennai [India] and the other "*Exploring the Principles of Circular Economy for the Leather and Leather Products Industry in Nigeria: Pathways for Sustainable Growth*" by **Dr. Jerry Tagang**, Director of Academic Planning, Nigerian Institute of Leather & Science Technology [Nigeria]. During Technical Session V, **Dr. K. J. Sreeram**, Outstanding Scientist and Former director, CSIR-CLRI [India] presented a keynote lecture on "*Towards Carbon Neutrality in Leather Industry*".

Out of the two **Knowledge Partner Lectures**, the first was delivered during Technical Session I on *"Vietnam Leather & Footwear Sector's 'Twin Transition' Strategy (Green & Digital): National Policies, Circular Economy Practices, and International Collaboration Roadmap",* by **Dr. Le Tran Vu Anh**, Vice Director & Chief Scientist, Vietnam Leather and Shoes Research Institute (LSI) [Vietnam] .The other one was delivered during Technical Session II by **Mr. Pham Phu Dung**, Director – Training & Technology Transfer Center, LSI [Vietnam] on "*Innovative Valorization of Solid Leather Waste and Green Tanning Technologies: Case Studies from LSI Vietnam*".

There were 29 technical paper presentations by participants from Kenya (1), Malaysia (1), Palestine (1), Sri Lanka (1), South Africa (1) and the host country India (24).

Prof. Nganga Stephen Irura, Associate Professor and Deputy Vice Chancellor – Finance, Administration & Planning, Garissa University [Kenya] delivered a presentation on "*Strengthening Dryland Leather Value Chains through Local Processing and Circular Principles*".

Mrs. Suraini Binti Mat Yasin, Head, Industrial Product Section (INDUSTRI), Department of Chemistry [Malaysia] presented a paper on "*Overview of Leather Authentication and Halal Verification in Malaysia: Analytical Approaches by the Department of Chemistry Malaysia*".

Dr. Eyad Yacoub Ahmed Yaqob, Assistant Professor, Department of Environmental Science and Technology, Arab American University [Palestine] presented a paper on *"Policy and Institutional Frameworks for Advancing Circular Economy in the Leather and Leather Product Sector in Palestine".*

Dr. Peshala Gunasekara, Research Scientist, Sri Lanka Institute of Biotechnology (SLIBTEC) [Sri Lanka] presented a paper on "*Sustainable Production of Pumpkin-Based Vegan Leather: A Waste-to-Value Biomaterial Innovation for Sri Lanka*".

Mr. Lee-Hendor Ruiters, Portfolio Manager: Circular Economy, Council for Scientific and Industrial Research [South Africa] delivered a presentation on "*From Tannery Waste to Value: Industrial Symbiosis Pathways under SACMI for South Africa's Leather & Leather Product Industries*".

Seven papers were presented during Technical Session II by: **Mr. Anish S. Inbaraj**, Research Scholar; **Mr. C. M. Rajesh**, Scientist-C; **Dr. S. Swarnalatha**, Scientist-E; **Dr. Bindia Sahu**, Scientist-E; **Mr. G. Ashok**, Research Scholar; **Ms. R. Sushmitha**, Research Scholar and **Dr. Rathiusha K.**, Research Scholar; all from CSIR-CLRI, India. Their respective presentations were on: "*Development of Protein-based Bio-composites from Raw Trimming Wastes: A Complete Waste Utilization strategy for Tanneries*"; "*Upcycling Footwear Roughing Waste into Composite Sheets and Shoe Components*"; "*Semiconducting porous carbon materials from chrome-tanned buffing dust*"; "*Novel Biobased Host-Guest Assembly for Improved Leather Performance*";"*Development of Electro spun Nanofibers Embedded with Activated Carbon from Tannery Solid Waste*"; "*Leather waste-derived carbon based Ag_2O-TiO_2nanocomposite for solar photodegradation of pharmaceutical pollutants*" and "*An expeditious technique for qualification of restricted substances in footwear and footwear materials at Innocuous levels*".

Six papers from CSIR-CLRI, India were presented in Session III, as follows: **Mr. Narendra Singh,** Sr. Technical Officer on "*Utilization of Lime Fleshings in Extraction of Tallow – A Case Study*"; **Ms. S. Swathy,** Research Scholar on "*Valorizing Tannery Solid Waste for Production of Technical Textiles – A Circular Economical Approach*"; **Dr. S. N. Vasagam,** Scientist-F on "*Trade Flows and Digital Traceability in Circular Leather and Footwear Value Chains*"**;** **Mr. P. Muthukumaran,** Technical Assistant on "*Waste-to-Resource Conversion of Kattha Industry Effluents into Vegetable Tanning Agents for Sustainable Leather Manufacture*"; **Mr. R. Prasanna**, Sr. Technical officer on "*Next-Generation Leather: Transforming Fish Waste into Fashion through Innovative Fish Skin Processing – Waste to Wealth*"; and **Mr. Harish Ragavendar**, Research Scholar on "*Circularity in Upcycling of Leather and Leather Product Manufacturing Wastes into Niche Products*".

The session IV included six talks from the following Indian Participants: **Ms. K. T. Aparna**, Research Scholar, CSIR-CLRI on "*Innovative Cyclodextrin Syntan for Ultra-Eco-Friendly and High-Performance Retanning of Leather*"; **Dr. A. Tamil Selvi**, Scientist-G, CSIR-CLRI on "*Sustainable Leather Coloring Using Biocolorants Derived from Natural Resources*"; **Ms. V. Janani,** Research Scholar, CSIR-CLRI on "*Amphoteric Biobased Polymeric System for Leather Lubrication*"; **Dr. G. C. Jayakumar**, Scientist-E, CSIR-CLRI delivered a presentation on "*Metamorphism of Sulfide-to-Sulfide Free Enzymatic Unhairing Process at Ethiopian Tanneries from CSIR-CLRI Lab"*; **Mr. T. Venkatachalam**, Research Scholar, CSIR-CLRI on "*Valorization of Tannery Waste into Protein Binders for Eco-friendly Leather Finishing*"; and **Mr. S. Jeyas Kandan**, Research Scholar, Department of leather Technology, Anna University on "*Single-Step Enzymatic Beamhouse Operation: An Approach to Cleaner Leather Manufacture*".

During the last Technical Session, five presentations were delivered by scientists from CSIR-CLRI, India: **Dr. M. Sathish**, Scientist-D on "*A Circularity Index Model for the Leather Sector*"; **Ms. M. S. Divya**, Scientist-C on "*An Approach for the Circular Economy in Leather through Artificial Intelligence*"; **Dr. S. Sundarapandiyan**, Scientist-E on "*Digital Carbon Footprint and Carbon Credit Assessment to Support Circular and Low-Carbon Tanning Operations: the CLI-Mate Platform*"; **Dr. S. V. Srinivasan**, Scientist-G on "*Zero Liquid Discharge (ZLD) in Leather Sector – towards Sustainability";* and **Dr. R. Renganath Rao**, Scientist-D on "*Not Waste, But Resource: A Circular Shift in Leather Processing*".

The **Concluding Session** was chaired by **Dr. K. J. Sreeram**. Extensive discussions were held during this session on **Chennai Resolution 2026** on *"Circular Economy in Leather and Leather Product Industries"* after which the **Resolution was unanimously adopted** by the participants with recommendations for the concerned ministries, agencies and other authorities in their countries.

Dr. P. Thanikaivelan in his closing remarks thanked **Dr. Amitava Bandopadhyay** for the efforts and inputs for giving everyone a platform to discuss on this very important topic. He also pointed out that the Leather Industry is not as bad as it is perceived by the common people and as a part of the industry; it is our duty to spread awareness about the importance of this important industrial sector. **Dr. Amitava Bandopadhyay**, in his **concluding remarks** thanked **Dr. P. Thanikaivelan** for his excellent leadership in the organization of this Workshop. He also thanked **Dr. R. Aravindhan** and the team at CSIR-CLRI for their untiring efforts in making the workshop a great success.

The participants also had a chance to visit the **'India International Leather Fair – 2026'** and fully utilize their visit to Chennai, India.

Chennai Resolution

On

Circular Economy in Leather & Leather Product Industries

WE, THE DELEGATES of the two-day International Workshop on "Circular Economy in Leather and Leather Product Industries in Developing Countries", organised by the Centre for Science & Technology of the Non-Aligned and Other Developing Countries (NAM S&T Centre) in partnership with CSIR-Central Leather Research Institute, a constituent laboratory under the Council of Scientific and Industrial Research (CSIR-CLRI), Chennai, and LERIG Trust at CSIR-CLRI, Chennai during 29-30 January 2026;

COMPRISING practicing tanners, footwear and leather product manufacturers, educationalists, researchers in academic and R&D institutions, NGOs and policy and decision makers in the government agencies and ministry departments of the developing countries from **India, Indonesia, Kenya, Malaysia, Nigeria, Palestine, South Africa, Sri Lanka and Vietnam**;

EXPRESSING GRATITUDE to the organisers and co-sponsors of the International Workshop;

CONSIDERING THAT the transition to a circular economy in the leather and leather products industry in developing countries is critical for resource efficiency, waste reduction and economic resilience, as the sector connects rural raw material producers to meet global standards with global sustainable markets and fashion brands;

DELIBERATING ON the current practices in circular economy implementation across leather value chain, including traceability, use of renewable raw materials for chemicals, waste valorization, closed-loop material flows, while analyzing policy, socio-economic and technological barriers in developing regions;

RECOGNISING THAT achieving circularity in the leather industry requires integrated approaches addressing resource recovery, zero-waste manufacturing, lifecycle assessments and inclusive stakeholder collaboration beyond linear models;

COMMITTING TO IDENTIFYING KEY CHALLENGES towards circular economy adoption in leather and leather product sectors of developing countries; identifying region-specific circular technologies and setting measurable implementation targets;

UNANIMOUSLY RESOLVE AND RECOMMEND the following:

1. The concerned ministries, departments, agencies and industrial entities should develop comprehensive circular economy roadmaps for the leather sector, integrating waste-to-resource strategies, regenerative materials and human resource development programmes;
2. Efforts should be made to establish a Circular Economy S&T Network to spearhead short-term and long-term country-specific R&D on leather waste upcycling and recycling, fostering South-South technology transfer and hands-on training;
3. Developing countries should adopt circular best practices across the leather value chain from raw hides to end-of-life recycling, creating diplomatic platforms for cross-border coordination and knowledge sharing;
4. Accelerated joint development of circular technologies should leverage local biomasses and manpower to convert leather wastes into high-value products like biopolymers, and leather plus materials;

5. Brands should endeavour to adopt and incentivize genuine leather, ecomarks, zero discharge of wastes, circular technologies, leading to net zero carbon footprint, extended product responsibility (EPR);
6. Brands should strive to integrate with biomaterial industries to generate high value collagen based materials from unutilized hides/skins and processed leathers;
7. Nations with high leather consumption should deploy investment mechanisms to scale circular value addition, such as extended producer responsibility schemes and green financing for closed-loop facilities;
8. R&D cooperation should be promoted to enhance circular value addition in leather products nationally and internationally, driving job creation in green manufacturing, poverty alleviation and improved livelihoods;
9. Entrepreneurial, technical and circular design skills should be built to transform the leather industry into a fully circular, economically viable, environmentally regenerative and socially inclusive ecosystem;
10. Industry 4.0 integration with circular principles should be prioritized, including digital twins for resource tracking, additive manufacturing from recycled inputs and AI-driven waste minimization;
11. Eco-friendly, circular raw materials for the fashion industry such as regenerated leather fibres should be developed to align with global climate commitments and circular economy standards;
12. Production-linked incentives and circular economic models that promote Gender Equality, Disability and Social Inclusion (GEDSI) and entrepreneurs should be implemented to accelerate growth in sustainable leather processing and product innovation;
13. Innovative circular accessories from leather by-products, like bio-composites and traceable embeds, should be explored to meet rising demands for zero-waste footwear and leather goods;
14. Design capabilities for circular leather products should be enhanced, focusing on modular, recyclable designs to climb the value chain, with training for local designers in customer-centric circularity;
15. Circular quality, safety and traceability standards should be established and enforced to gain competitive advantages in global green markets;
16. Technologies for converting leather, leather products and footwear industry wastes into new materials and products, such as energy recovery and biochar, should be prioritized for zero-waste goals;
17. Governments in developing countries should provide financial, technical, policy support, incentives, concessional capital and subsidies to mainstream circular practices in leather and leather product industries;
18. Research-industry linkages and circular economy incubators, forming global stakeholder working groups that foster to enable technical consultancy, skill training, entrepreneurship in upcycling, technology transfer and startup nurturing in sustainable leather value chains.

The above recommendations may be submitted to the governments and other relevant stakeholders of the developing countries for their appropriate action.

THUS, RESOLVED AND UNANIMOUSLY ADOPTED ON THIS DAY, THE 30th OF JANUARY 2026, AT CHENNAI (TAMIL NADU), INDIA.

Joint NAM S&T Centre – JSS AHER, Mysuru, India Fellowship Programme 2025

Research Completion Report of Dr. Mohammed Kamal Abdelalem Rashed,

Doctoral Researcher, National Research Center (NRC), Giza, Egypt

"***Next-Generation Sequencing in Water Quality Monitoring: Bacteriophages as Viral Indicators for Detecting Enteric Viruses***"

Dr. Mohammed Kamal Abdelalem Rashed undertook his research under the Supervision of **Prof. Dr. Akila Prashant**, Professor and Head, Department of Biochemistry, JSS Medical College, JSS Academy of Higher Education and Research, Mysuru, Karnataka, India.

Waterborne viruses remain a major global concern due to their strong resistance to environmental factors and wastewater treatment processes. In this project, special focus was given to the use of droplet digital PCR (ddPCR) for the detection and quantification of viral indicators in wastewater samples. Although the original proposal aimed to utilize Next-Generation Sequencing (NGS), the study instead focused on the detection of bacteriophages, which are considered reliable viral indicators of enteric viruses. Specifically, phages such as PhiX174 and crAssphage were targeted, along with selected enteric viruses including rotaviruses, adenoviruses and pepper mild mottle virus (PMMoV). The ddPCR technique proved to be a precise, sensitive and cost-effective molecular approach for viral monitoring in wastewater. This technique allows for absolute quantification of viral targets without the need for standard curves, offering improved sensitivity and reproducibility and is complemented by full genome sequencing using NGS.

Wastewater samples were collected from the Kesare Wastewater Treatment Plant in Mysore. These samples were concentrated by using polyethylene glycol (PEG) and ultracentrifugation. Nucleic acids were extracted using standard viral RNA/DNA extraction kits. The detection and quantification of the target viruses and bacteriophages were carried out using ddPCR, which partitions each reaction mixture into thousands of nanoliter-sized droplets to allow precise measurement of target copy numbers. Specific primers and probes were used for each viral target, and results were analyzed using QuantaSoft software to calculate absolute genome copies per milliliter of sample. Some samples were also prepared for metagenomes.

During the short period of the fellowship, the results are expected to demonstrate the co-detection of bacteriophages and enteric viruses in wastewater samples, supporting the potential use of bacteriophages as supplementary viral indicators in water quality monitoring. This approach may provide valuable insights for policymakers to enhance water safety strategies.

Future research will expand this study by comparing the viral profiles of wastewater from India and Egypt, using the same ddPCR protocols. This comparison will help understand geographical differences in viral occurrence, environmental resistance, and the correlation between bacteriophages and enteric viruses in both regions. The results could lead to a proposed unified framework for viral monitoring applicable to developing countries.

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Group Photo of International Workshop on "Promoting Blue Economy and Overcoming its Implementation Challenges"

Small Island Developing States (SIDS), underscoring the need for stronger policies, investment in ocean science research and global cooperation aligned with the UN Sustainable Development Goal – 14 (Life Below Water).

In view of the significant economic potential of Blue Economy in the developing countries, especially in the Small Island Developing States such as Mauritius, Sri Lanka, Seychelles etc., the Centre for Science and Technology of the Non-Aligned and Other Developing Countries (NAM S&T Centre), New Delhi, in collaboration with the Ministry of Tertiary Education, Science and Research, Mauritius, successfully organised an International Workshop on "**Promoting Blue Economy and Overcoming its Implementation Challenges**" during 26-27 March, 2026 in Flic en Flac, Mauritius. The Workshop brought together nearly 50 participants, including scientists, policymakers, researchers and academicians from 7 countries namely **Egypt, India, Kenya, Malaysia, Mauritius, Myanmar** and **South Africa**.

The two-day Workshop was focused on advancing the blue economy and addressing its key implementation challenges, with particular emphasis on the unique vulnerabilities, governance needs and sustainable development priorities of coastal and small island states. The programme included **4 Technical Sessions**, **3 Keynote Lectures, 8 Paper Presentations** and a **Panel Discussion**.

The **Opening Ceremony** began with an Opening Remarks by **Prof. (Dr.) Kiran Bhujun**, Director, Tertiary Education and Scientific Research, Ministry of Tertiary Education, Science and Research, Mauritius. In his remarks, Prof. (Dr.) Bhujun welcomed the participants and appreciated that their presence reflects a shared recognition of the future of our economies, particularly for small islands and coastal states. It is also closely tied to the sustainable use of ocean resources. He extended his appreciation to **Dr. Amitava Bandopadhyay**, Director General of the NAM S&T Centre, for his foresight in advancing this initiative.

Dr. Amitava Bandopadhyay, Director General of the NAM S&T Centre, New Delhi then presented his remarks. Dr. Bandopadhyay highlighted the critical role of ocean science and technology in sustainable management of ocean resources and drew attention to the key challenges faced by developing countries especially the SIDS. He also acknowledged Mauritius as an active and valued member of the NAM S&T Centre and appreciated its continued collaboration in organizing various scientific programmes jointly with the NAM S&T Centre. He also reiterated the Centre's commitment to strengthening international cooperation, promoting knowledge exchange and fostering partnerships among its Member Countries.

A Virtual Address was delivered by the **Chief Guest**, **Dr. The Honourable Kaviraj Sharma Sukon**, Minister of Tertiary Education, Science and Research, Mauritius. He highlighted how we can make science diplomacy a reality and transform science into a pillar of our economy. He emphasized the need to work together to move from experiments in universities to concrete solutions that address national level challenges and to transform research outcomes into practical applications.

During the inaugural session, a **Memorandum of Understanding (MoU)** was signed between the Ministry of Tertiary Education, Science and Research, Republic of Mauritius and the International Science, Technology and Innovation Centre for South-South Cooperation (ISTIC) under the auspices of UNESCO, Malaysia, to strengthen collaboration in Science, Technology and Innovation and capacity building.

Keynote Lecture I titled "*Malaysia's Blue Economic Plan: Unlocking the Value of the Oceans*" was delivered by **Prof. Mahendhiran Sanggaran Nair**, Pro-Vice Chancellor, Sunway University, Malaysia. In his lecture, Prof. Nair underscored the contribution of the Blue Economy to national GDP, with a strong focus on the Return on Value (RoV) from investments in Blue Economy sectors demonstrating how strategic investments can generate long-term social, economic and environmental benefits.

Keynote Lecture II titled "*How Government, Education and Industry Should Integrate the Blue Economy Message to Inspire the Next Generation*" was delivered by **Dr. Jessica Fraser** from South Africa. In her lecture, Dr. Fraser focused on how governments, education systems and industry must work together to integrate and promote the Blue Economy vision to inspire the next generation.

Technical Session I on "***Marine Research and Innovation: A Blue Economy Perspective***" was chaired by **Dr. Vidushi Neergheen** from Mauritius. Two papers were presented in this session. **Dr. Nandini Savoo-Calotte**, Mauritius, presented the paper on "*Building Blue Resilience through Promotion of Research and Innovation*". She summarised that following the MV Wakashio Oil Spill in southeast of Mauritius in 2020, the MRIC launched a special call for innovative projects to accelerate national response, recovery and environmental remediation efforts.

Dr. Rahul Kaushik from NIO, India in his paper on "*Living and Non-Living Resources from the Ocean: Opportunities, Challenges and Solutions*" highlighted that Blue Economy promotes sustainable use of ocean resources - both living and non-living. He also emphasized clean technologies, alternative sources like ocean-based critical minerals and waste valorisation to address resource depletion, reduce pollution and advance a circular economy.

Technical Session II on "***Blue Finance, Investment, Governance and Policy for Small Island Developing States***" was chaired by **Mr. David Phhilippe**, Mauritius. Under this technical session, a paper presentation titled "*Strengthening Legal and Institutional Frameworks for Sustainable Ocean Governance in the Blue Economy*" was given jointly by **Dr. (Mrs.) Bhavna Mahadew** and **Dr. Kavi B. Nowbutsing**, Mauritius. It was highlighted that strengthening ocean governance lies in developing regionally integrated national ocean policies, supported by stronger institutional coordination, enhanced regional and international cooperation and South-South collaboration. Additionally, sustained investment in science, technology, and capacity building are crucial to ensure effective and inclusive ocean governance.

Following the above, a presentation titled "*Climate Policy Gap Analysis for Ocean Governance and Sustainable Blue Economy in SIDS: Case Study of Mauritius*" was given jointly by **Dr. Kavi B. Nowbutsing**, **Mr. Ramneesh Taka** and **Dr. (Mrs.) Bhavna Mahadew**, Mauritius. Their study concluded that Mauritius has strategically navigated climate governance by building strong narratives and positioning itself effectively at regional and global levels. However, despite these efforts, notable policy gaps continue to persist, highlighting the need for more coherent integration and stronger implementation mechanisms.

Technical Session III on "***Sustainability of the Ocean Environment: Environmental Management and Socio-Economic Dimensions***" was chaired by **Prof. Mahendhiran Sanggaran Nair**, Malaysia. Under this technical session, **Dr. Myat Soe Aung**, Myanmar presented a paper on "*Strategic Review on the Opportunity, Challenges and Sustainable Development of Myanmar's Blue Economy towards a Sustainable Future*". He highlighted that Myanmar's rich marine resources offer strong Blue Economy potential, but it is threatened by overfishing, habitat degradation, pollution and climate change. He proposed an integrated approach combining coordinated governance, capacity building and innovative blue financing to achieve a sustainable and resilient Blue Economy.

This was followed by a short presentation by **Prof. Mahendhiran Sanggaran Nair**, Malaysia. Dr. Nair highlighted that strong Blue Economy stewardship leads to effective governance systems, supported by strong internal and supply chain partnerships. However, several major challenges remain. The Blue Economy cuts across multiple ministries, agencies, jurisdictions and industries, making coordination complex. In addition, the lack of long-term planning and coordination, poorly designed KPIs and uncoordinated strategies and investments continue to hinder overall progress.

Technical Session IV on "***Sustainable Ocean Tourism, Coastal Livelihoods, Education and Capacity Building for Blue Economy***" was chaired by **Dr. Jessica Fraser** from South Africa.

During this session, **Keynote Lecture III** titled "*Re-engineering Tertiary Education and Training for Sustainable Development of Blue Economy in the Lake Victoria Region of Kenya*" was delivered by **Prof. Elyjoy Muthoni Micheni**, Kenya. In her lecture, Prof. Micheni highlighted that Kenya's Blue Economy currently contributes approx. 0.7% to the national GDP, with its future growth closely tied to capacity building within the Lake Victoria Economic Bloc (LREB). She examined the role of universities and TVET institutions in developing relevant skills, advancing research and aligning educational outcomes with the national Blue Economy priorities.

Following the Keynote Lecture, there were two technical paper presentations. The first paper was by **Ms. Fatma Hegazy**, Egypt, on "*Integrating Tourism and Environmental Policy in Egypt's Blue Economy Framework*". She highlighted that Egypt's Blue Economy holds significant potential for sustainable growth across various sectors. However, the progress is constrained by many challenges. She emphasized that strengthening policy coordination, improving regulatory enforcement and enhancing stakeholder engagement are critical to advancing a resilient and sustainable Blue Economy in Egypt.

In the second paper, **Dr. Fakrul Hazely Bin Ismail** from Malaysia, presented a paper on "*Promoting the Blue Economy and Overcoming Its Implementation Challenges in the Sports Sector: A Conceptual Framework for Sustainable Coastal Sport Development*". He proposed the Blue Economy Sport Sustainability Model (BESSM), and concluded that stronger governance, eco-certification and stakeholder education are essential to transform coastal sport development into a sustainable and resilient contributor to the Blue Economy.

A **Panel Discussion** was then held on the theme "***Blue Economy Roadmap for Developing Nations: Opportunities, Challenges and Regional Cooperation***". The panel experts included were: Prof. Mahendhiran Sanggaran Nair (Malaysia), Dr. Vikash Munbodhe (Mauritius), Dr. Jessica Fraser (South Africa) and Prof. Elyjoy Muthoni Micheni (Kenya), and was moderated by Madam Sharizad Dahlan (Malaysia). A central question was whether we are effectively moving from ambition to implementation of the Blue Economy, particularly in developing countries where progress remains uneven. The discussion focused on key opportunities, barriers to progress and the way forward. Prof. Nair emphasized "Leadership" as the most critical factor, highlighting the need for stronger alignment and collaboration among stakeholders to translate intent into action. Dr. Munbodhe stressed that Blue Economy initiatives must be both ecologically sustainable and economically viable. He noted that the concept has evolved into a scientific necessity in the post-pandemic context. Mauritius is advancing a Marine Spatial Plan with significant completion, though challenges remain in transitioning the fisheries sector, which requires strong research support to move from over-exploited shallow water resources to deep-sea potential. Dr. Fraser shifted the focus from "Leadership" to "Ownership," emphasizing that the responsibility at individual level drives sustainability. She illustrated this through community participation during Nelson Mandela Day. Prof. Micheni highlighted that current education systems are lagging behind Blue Economy demands, stressing the need for better alignment with the market needs. Prof. Nair further described that the Blue Economy is in its fifth generation - a "regenerative phase" that prioritizes planetary health, marking a shift from earlier stages that were largely extractive in nature. Dr. Munbodhe further added that Mauritius is developing an action plan focusing on fisheries, resource mapping and biodiversity assessment, supported by research and policy inputs. While knowledge sharing is improving best practices, challenges such as low investment, petroleum-related issues and reluctance within the fishing industry persist. The panel concluded that sustained investment, policy coordination and strong leadership are essential to advance the Blue Economy and translate commitments into tangible outcomes.

Concluding remarks were delivered by Prof. (Dr.) Kiran Bhujun and Dr. Amitava Bandopadhyay, who appreciated the valuable contributions of all participants for a successful organisation of the Workshop.

Signing of Memorandum of Understanding (MoU)

Centre for Science and Technology of the Non-Aligned and Other Developing Countries (NAM S&T Centre), New Delhi, India

and

Energy Management Centre (EMC), Department of Power, Govt. of Kerala, Thiruvananthapuram, Kerala, India

On **8 February 2026**, **NAM S&T Centre** and **EMC** formalized a new partnership by signing a **Memorandum of Understanding (MoU)**. This MoU establishes a collaborative framework between the two parties aimed at advancing scientific cooperation and promoting mutual interests in the areas of science and technology, especially energy and related issues.

The MoU was signed by **Dr. R. Harikumar**, Director, EMC and **Dr. Amitava Bandopadhyay**, Director General of the NAM S&T Centre.

The MoU outlines several key areas of cooperation, reflecting the shared interests and goals of both the parties. These initiatives aim to promote knowledge exchange, enhance research capabilities and contribute to the advancement of science and technology.

Through this partnership, both institutions aim to promote capacity building, knowledge exchange and scientific advancement, fostering long-term collaboration in various fields of science and technology, especially energy and related issues. The joint programs and publications will provide valuable opportunities for scientists and researchers from the developing world to enhance their skills and contribute to global scientific progress.

Renewal of Memorandum of Understanding (MoU)

Centre for Science and Technology of the Non-Aligned and Other Developing Countries (NAM S&T Centre), New Delhi, India

and

Indian Ocean Rim Association (IORA), Ebene, Mauritius

In order to strengthen ties and to work together for the promotion of Science, Technology & Innovation (STI) with particular emphasis on *"Sustainable Development in the Global South"*, the **Indian Ocean Rim Association (IORA)** and the **NAM S&T Centre**, renewed their **Memorandum of Understanding (MoU)** on **26 March 2026**.

The MoU was signed in Mauritius by **H.E. Ambassador Sanjiv Ranjan**, Secretary General, IORA, Mauritius and **Dr. Amitava Bandopadhyay**, Director General, NAM S&T Centre, New Delhi.

The objective of the *MoU* is to re-establish the basis for an organizational arrangement in order to encourage engagement in the broad fields of academic, science and technology for capacity building and joint activities to achieve Sustainable Development Goals (SDGs) through the application of STI in the IORA and NAM S&T Centre's member states for mutual benefits, and on the basis of equality and reciprocity. The signatory partners will further encourage the development of collaborations on multilateral R&D and human resource development programs in which both partners have common interests; and will also promote sharing and exchange in the areas of STI to develop and reinforce potential synergies, enhance public awareness and dialogue.

This renewed collaboration underscores the shared vision of the NAM S&T Centre and IORA to foster South-South cooperation and promote inclusive and sustainable development through science, technology and innovation.

Special Feature

Council of Scientific and Industrial Research (CSIR), India: A Research and Innovation Hub for Global Sustainable Development

Part 2: CSIR's Initiatives in Addressing Emerging Environmental Challenges through Science-Driven Solutions

Contributors: *CSIR-National Environmental Engineering Research Institute (CSIR-NEERI), CSIR-Indian Institute of Petroleum (CSIR-IIP), CSIR-Indian Institute of Chemical Technology (CSIR-IICT), CSIR-National Institute for Interdisciplinary Science & Technology (CSIR-NIIST) and CSIR-International S&T Affairs Directorate (CSIR-ISTAD)*

The Council of Scientific and Industrial Research (CSIR), India, continues to be a cornerstone of India's scientific and technological advancements, driving national growth through its robust network of 37 laboratories and their Outreach Centres across the country. With a strong focus on developing and deploying science-driven, scalable technologies, CSIR addresses critical challenges across both urban and rural landscapes.

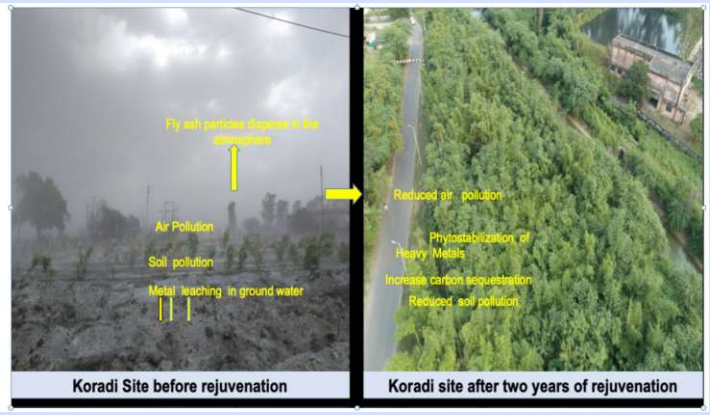
CSIR's research and innovation ecosystem spans almost every major industrial sector, including ecology, environment, genomics, biotechnology, pharmaceuticals, healthcare & wellness, food processing, agriculture, aroma & floriculture, rural & cottage industries, leather & allied sectors, chemicals & fertilizers, infrastructure & construction, mining, minerals & metals, energy & fuels, electronics, aerospace, etc. Through these wide-ranging interventions, CSIR plays a vital role in strengthening India's industrial competitiveness while ensuring inclusive and sustainable development (https://techindiacsir.anusandhan.net /online/Control.do?_idx).

To elaborate and present CSIR's efforts and its capabilities in the area of "Generic drugs", the CSIR article entitled "Contribution of CSIR-India in establishing India as the Pharmacy of the world" was published in the NAM S&T Quarterly Newsletter, Oct - Dec 2024 Issue, Vol. 34, No. 3.Continuing with CSIR's efforts, the present article showcases CSIR's approaches towards tackling emerging environmental challenges using science-based solutions. CSIR has been at the forefront of developing and deploying indigenous technologies that address global pressing challenges being faced by India, particularly in ecology and environmental sustainability. Addressing emerging environmental challenges through science-driven and mission-oriented approaches, CSIR integrates advanced materials, digital tools, biotechnology, and process engineering to deliver sustainable outcomes. Through its extensive network of laboratories and field centres, CSIR has translated cutting-edge research into on-ground solutions for air and water pollution control, solid and hazardous waste management, ecosystem restoration, and climate resilience. From lake and river rejuvenation, decentralised wastewater treatment systems, and real-time environmental monitoring to remediation of contaminated soils and groundwater, CSIR technologies have been implemented across urban, peri-urban, and rural settings. These field-deployed solutions are designed to be scalable, cost-effective, and adaptable to diverse Indian conditions, ensuring tangible environmental improvements while supporting public health and livelihoods.

Innovations in carbon capture and utilization, waste-to-wealth, circular economy, and nature-based solutions exemplify CSIR's commitment to climate mitigation and resource efficiency. By coupling laboratory excellence with pilot-scale demonstrations and large-scale deployments, CSIR bridges the gap between research and societal impact. These efforts not only support national priorities such as clean air, clean water, and net-zero transitions, but also contribute to global sustainability goals, reinforcing CSIR's role as a key driver of environmentally responsible and technologically empowered development in India. Adopting a thematic and mission-oriented approach, CSIR actively supports key National Missions of India and contributes meaningfully to the United Nations Sustainable Development Goals (SDGs). Through this integrated framework, CSIR continues to translate cutting-edge science into impactful technologies, reinforcing India's journey towards a self-reliant, sustainable, and innovation-driven future.

CSIR extensively engages with a variety of stakeholders to provide science-based solutions to diverse environmental challenges. Below are some of CSIR's key mature, field-tested environmental technologies that directly contribute to climate action, resource efficiency and sustainable development.

a) **CSIR-NEERI's Eco-Restoration-know-how for rejuvenation of degraded and contaminated land:** This is a novel approach which integrates soil chemistry, microbial processes, organic amendments and ecological engineering to rehabilitate industrial wastelands, fly ash dumps and mining-impacted areas. These interventions restore soil functionality, stabilize contaminants and promote long-term ecological succession. The approach has been successfully deployed for rejuvenation of degraded lands across the country, including at Koradi, Khaparkheda, and Chandrapur Thermal Power Stations in Maharashtra's Vidarbha districts in India , wherein more than 1500 hectares of severely degraded land has been rehabilitated (https://www.youtube.com/watch?v=VLTx89XipIc). This also results in enhanced carbon sequestration, reduced environmental risks and enables productive reuse of degraded land while supporting biodiversity conservation.



b) **CSIR's advances in biomethanation and circular bio-resource management**: CSIR-IICT has

demonstrated and deployed advanced biomethanation technologies capable of efficiently converting diverse organic waste streams into biogas and nutrient-rich bio-manure through compact and decentralised systems. These scalable waste-to-energy solutions that reduce greenhouse gas emissions, support renewable energy generation and strengthen circular economy frameworks for urban and institutional waste management. A Biogas plant with capacity to process 1000 kg/day food waste and with production of **140 m^3/day of biogas and Liquid Biomanure of about 1200 L/day** is successfully in operation since 2016. Another success story includes AGR based biogas plant deployed at Siddipet, Telangana, India wherein **slaughter house waste** containing **40 KLD Blood waste and 500 kg/day solid gut waste** is treated to **generate 80 m^3/day biogas**. The technology has been licensed to **M/s Nyrmalya Bioengineering Solutions, Hyderabad, India**. Additionally, CSIR-NIIST has developed a **compact size solid-state anaerobic digestion system**(food waste to bioenergy) with wide applications across various sectors, including houses, apartments, food courts, restaurants, and community halls.

1000 kg/day Biogas plant in TAPF Kitchen at Hubli, Karnataka, India

AGR based Biogas plant at Siddipet, Telangana, India

c) **CSIR-IIP's Bioaviation fuel and Renewable Diesel technology**: In the domain of clean fuels, CSIR-IIP has developed an innovative process for production of Bioaviation fuel and Renewable Diesel, utilising used cooking oil, non-edible oils and agro-forestry residues. A 1 TPD green biodiesel plant is installed at Gujarat, India and Demo plant of 9000TPA will be ready by 2027 at Mangalore, India (https://www.iip.res.in/business-development/en/innovative-technologies-from-csir-iip/). The process is energy-efficient, environmentally benign and suitable for decentralised and mobile deployment. The process offers a globally distinctive biodiesel technology with significantly lower life-cycle greenhouse gas emissions, supporting waste-to-fuel value chains, sustainable mobility and rural entrepreneurship.

Bioaviation Fuel and Renewable Diesel Plant

d) **CSIR-NIIST's onsite wastewater treatment systems (NOWA)**: Addressing water and sanitation challenges, CSIR-NIIST has developed resource-oriented onsite wastewater treatment systems designed for decentralised applications. These systems integrate anaerobic and aerobic processes to recover treated water, bioenergy and nutrients, particularly for small towns, institutions and peri-urban areas lacking centralised sewerage infrastructure. The system exhibits practical, low-footprint solutions enabling water reuse, pollution reduction and climate resilience while transforming wastewater into a valuable resource (https://www.niist.res.in/research-areas/Environmental%20Technology%20Division%20%28ETD%29).

NOWA – the Decentralised Wastewater Treatment System of CSIR-NIIST

The above-mentioned technologies/processes are just few representative glimpses of CSIR's technological interventions related to environmental challenges that reflect CSIR's ability to bridge laboratory research with field-level deployment through collaboration with industry, urban local bodies and other stakeholders. This integrated innovation pathway ensures that solutions are not only scientifically robust but also economically viable and socially relevant.

CSIR offers excellent opportunities for collaboration in the sector of climate mitigation, improving resource efficiency and ecosystem sustainability. As the world progresses towards the 2030 Agenda for Sustainable Development, CSIR's technology portfolio, grounded in scientific excellence and oriented towards real-world impact, continues to contribute meaningfully to building a resilient, inclusive and low-carbon future. CSIR welcomes collaborations for pursuing cutting-edge R&D and technology partnerships from relevant RTOs, industries and start-ups.

For partnership interest, please contact:

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Science, Technology & Innovation News

HEALTH

Fast, simple method can detect key immunity biomarker in blood

Researchers at St. Petersburg University have developed an efficient way to detect a crucial immunity biomarker—neopterin—in the blood using nanotechnology and a laser. Neopterin is a nucleotide whose blood levels rise sharply in cases of viral infections, autoimmune or oncological diseases, implant rejection and inflammatory processes. Normally, the concentration of this substance in the blood is very low, and besides neopterin, blood contains many other compounds, making it difficult to detect and reliably determine the quantity of these molecules in the human body. Existing methods, such as chromatography and mass spectrometry, require complex sample preparation, resulting in each analysis taking a considerable amount of time. Therefore, these methods are not highly efficient, which can be critical for some patients. Scientists from St. Petersburg University, staff members of the SPbU Laboratory of Plasmon-Enhanced Spectroscopy and Bioimaging, together with colleagues from the University's Bio Photonics scientific group, have developed an alternative, much faster, and equally reliable method for detecting this marker in human blood. The work has been published in the journal *Spectrochimica Acta Part A: Molecular and Biomolecular Spectroscopy*. Elena Solovyova, Associate Professor at the Department of Physical Chemistry, SPbU explaine that researchers applied surface-enhanced Raman spectroscopy to analyze neopterin directly in blood serum. This technique makes the neopterin molecules 'scream' under the laser so loudly that they become clearly 'audible' amidst all the 'noise' of the blood. This approach simultaneously solves the issues of speed, simplicity, and sensitivity, allowing measurements to be taken almost immediately and results obtained quickly. The scientists synthesized gold nanoparticles and assembled them into aggregates using hydrochloric acid. In this arrangement, zones of significantly greater electromagnetic field enhancement appear in the gaps between closely spaced nanoparticles compared to what a single particle provides. If the target molecule falls into these gaps, its optical signal gets amplified millions of times. Simultaneously, the developers identified unique spectral "marker bands" that can reliably distinguish neopterin from other molecules, including amino acids and proteins, which are abundant in the blood.

To ensure the analysis results are reliable and independent of local factors, such as particle concentration or laser power the SPbU scientists employed a so-called internal control. The method created by St. Petersburg University scientists "sees" nanomolar concentrations of compounds and clearly identifies neopterin among numerous other blood components. Using the method, a blood serum sample is mixed with ready-made gold nanoparticles and acid—the result can be obtained within minutes. According to the researchers, the development can be adapted for monitoring the severity of viral infections, evaluating therapy effectiveness for autoimmune diseases, and observing post-transplant patients, as the analyzed molecule is a marker for related pathologies.

medicalxpress.com; February 16, 2026

ARTIFICIAL INTELLIGENCE

Graphene-based 'artificial skin' brings human-like touch closer to robots

Robots are becoming increasingly capable in vision and movement, yet touch remains one of their major weaknesses. Now, researchers have developed a miniature tactile sensor that could give robots something much closer to a human sense of touch. The technology, developed by researchers at the University of Cambridge, is based on liquid metal composites and graphene—a two-dimensional form of carbon. The "skin" allows robots to detect not just how hard they are pressing on an object, but also the direction of applied forces, whether an object is slipping, and even how rough a surface is, at a scale small enough to rival the spatial resolution of human fingertips. Their results are published in the journal *Nature Materials*. Human fingers rely on multiple types of mechanoreceptors to sense pressure, force, vibration, and texture simultaneously. Reproducing this level of multidimensional tactile perception in artificial systems is a significant challenge, especially in devices that are both small and durable enough for practical use."Most existing tactile sensors are too bulky, too fragile or too complex to manufacture or unable to accurately distinguish between normal and tangential forces," said Professor Tawfique Hasan from the Cambridge Graphene Center, who led the research. This has been found to be a major barrier to achieving truly dexterous robotic manipulation. To overcome this, the research team developed a soft, flexible composite material, combining graphene sheets, deformable metal microdroplets, and nickel particles, embedded in a silicone matrix. Inspired by the microstructures found in human skin, the researchers shaped the material into tiny pyramids, some as small as 200 micrometers across. These pyramid structures concentrate stress at their tips, enabling the sensor to detect extremely small forces while maintaining a wide measurement range. The result is a tactile sensor sensitive enough to detect a grain of sand. Compared with existing flexible tactile sensors, the new device improves size and detection limits by roughly an order of magnitude. The sensor can also distinguish shear forces from normal pressure, a capability that allows it to detect when an object begins to slip. By measuring signals from four electrodes beneath each pyramid, the sensor can mathematically reconstruct the full three-dimensional force vector in real time. In demonstrations, the team integrated the sensors into robotic grippers. The robots were able to grasp fragile objects, such as thin paper tubes, without crushing them. Unlike conventional force sensors, which rely on prior information about an object's properties, the new system adapts in real time through slip detection. At even smaller scales, microsensor arrays could identify the mass, geometry, and material density- of tiny metal spheres by analyzing force magnitude and direction. This opens the door to applications in minimally invasive surgery or microrobotics, where conventional force sensors are far too large. Beyond robotics, the technology could have significant implications for prosthetics. Advanced artificial limbs increasingly rely on tactile feedback to provide users with a sense of touch. Highly sensitive, miniaturized 3D force sensors could enable more natural interactions with objects, improving control, safety, and user confidence. "Our approach shows that bulky mechanical structures or complex optics are not required to achieve high-resolution 3D tactile sensing", said lead author Dr. Guolin Yun, a former Royal Society Newton International Fellow at Cambridge, and now Professor at the University of Science and Technology of China. "By combining smart materials with skin-inspired structures, we achieve performance that comes remarkably close to human touch." Looking ahead, the researchers believe that the sensors could be miniaturized even further, potentially below 50 micrometers, approaching the density of mechanoreceptors in human skin. Future versions may also integrate temperature and humidity sensing, moving closer to a fully multimodal artificial skin. As robots increasingly move out of controlled factory environments and into homes, hospitals, and unpredictable real-world settings, such advances in touch could be transformative, allowing machines not just to see and act, but to truly feel.

techxplore.com; March 5, 2026

New AI model could cut the costs of developing protein drugs

MIT researchers used a large language model to optimize the genetic sequences of proteins manufactured by yeast, making production more efficient.

Industrial yeasts are a powerhouse of protein production, used to manufacture vaccines, biopharmaceuticals, and other useful compounds. In a new study, MIT chemical engineers have harnessed artificial intelligence to optimize the development of new protein manufacturing processes, which could reduce the overall costs of developing and manufacturing these drugs. Using a large language model (LLM), the MIT team analyzed the genetic code of the industrial yeast *Komagataella phaffii* — specifically, the codons that it uses. There are multiple possible codons, or three-letter DNA sequences, that can be used to encode a particular amino acid, and the patterns of codon usage are different for every organism. The new MIT model learned those patterns for *K. phaffii* and then used them to predict which codons would work best for manufacturing a given protein. This allowed the researchers to boost the efficiency of the yeast's production of six different proteins, including human growth hormone and a monoclonal antibody used to treat cancer.

news.mit.edu; February 16, 2026

ELECTRONICS & SEMICONDUCTORS

Atom-thin material could help solve chip manufacturing problem

Making computer chips smaller is not just about better design. It also depends on a critical step in manufacturing called patterning, where nano scale structures are carved into materials to form the circuits inside everything from smart phones to advanced sensors.To create these patterns, engineers use a hard mask, a thin, durable material layer that protects selected regions while the exposed areas are etched away. According to Saptarshi Das, Penn State Ackley Professor of Engineering Science and professor of engineering science and mechanics, as the chips get smaller, the manufacturing process becomes much more demanding. He said that the mask used to define these patterns must survive extremely harsh processing conditions. If the mask degrades, the patterns cannot be transferred reliably.

Das and his team of international researchers reported in a study published in *Nature Materials* that an atomically thin two-dimensional (2D) material, chromium oxychloride (CrOCl), dramatically outperforms conventional hard mask materials used in chip fabrication."The industry is really struggling to find new hard mask material", said Das, corresponding author of the study. "As chips move toward smaller dimensions and more complex 3D architectures for faster and better electronics, we need different hard mask materials to make it easier to manufacture the chips". 2D metal oxyhalides such as chromium oxychloride, niobium oxychloride may be the answer, according to the researchers. Ziheng Chen, Penn State doctoral candidate in engineering science and mechanics and co-author of the study, explained that the material's layered crystal structure plays a key role in these advantageous properties."This 2D material is like lasagna", Chen said. "It's a layer-by-layer structure". Instead of strong chemical bonds between layers, the sheets are loosely held together. When exposed to plasma, the material forms what Chen described as a protective surface. "When the plasma is bombarding the surface, it will form a passivation layer", he said. "That layer becomes chemically inert and shields the material underneath from further reaction." The discovery that chromium oxychloride could handle exposure to plasma could work with more delicate materials was unexpected, according to Das. "We did not really anticipate that this chromium oxychloride was going to be a hard mask material", Das said. "It was experimental serendipity". According to Pranavram Venkatram, Penn State doctoral candidate, the material could potentially reduce fabrication complexity and eliminate the need to repeatedly redeposit masking layers during deep etching steps. Still, more work remains before the technology can be scaled up for industrial use. So far, the demonstrations have been performed on small, exfoliated flakes of material. "This material, with its simpler fabrication and compatibility, could potentially be a gamechanger for future electronics development and manufacturing", Das said.

techxplore.com; March 10, 2026

BIOCHEMICAL ENGINEERING

Scientists turn methane into medicine in stunning breakthrough

Scientists from Center for Research in Biological Chemistry and Molecular Materials (CiQUS) at the University of Santiago de Compostela) have unveiled a breakthrough way to turn natural gas—long burned as fuel—into valuable chemical building blocks for medicines and other high-demand products. By designing a clever iron-based catalyst powered by LED light, researchers managed to activate stubborn molecules like methane and transform them into complex compounds, even creating the hormone therapy drug dimestrol directly from methane for the first time.

Natural gas is one of the most plentiful energy resources on Earth. It is made mostly of methane, along with ethane and propane. Today, it is primarily burned for heat and electricity, a process that releases greenhouse gases. For years, researchers and industry leaders have tried to find ways to convert these simple hydrocarbons directly into useful chemicals instead of burning them. The challenge is that methane and similar gases are extremely stable and do not react easily, which has limited their use as sustainable raw materials for manufacturing. A research team led by Martín Fañanás at the CiQUS, University of Santiago de Compostela has now developed a new method to transform methane and other components of natural gas into versatile chemical "building blocks" that can be used to make high value products, including pharmaceuticals. The study has been published in *Science Advances*, marks an important step toward a more sustainable and circular chemical economy. In a landmark demonstration, the team synthesized a bioactive compound directly from methane for the first time. The compound, dimestrol, is a non-steroidal estrogen used in hormone therapy. Producing such a complex molecule from methane highlights the potential of this approach to turn an abundant, inexpensive gas into sophisticated and commercially important chemicals. The researchers focused on a reaction known as allylation. This process attaches a small chemical fragment called an allyl group to a gas molecule, effectively giving it a functional "handle" (an allyl group) that chemists can build on in later steps. With this handle in place, the modified molecule can be transformed into a wide range of products, from pharmaceutical ingredients to common industrial chemicals. One major obstacle in the process was the tendency of the catalytic system to trigger unwanted chlorination reactions, which created by-products and reduced efficiency. Controlling these side reactions was essential to making the process practical. To solve this problem, the team designed a specialized supramolecular catalyst. "The core of this breakthrough lies in designing a catalyst based on a tetrachloroferrate anion stabilized by collidinium cations, which effectively modulates the reactivity of the radical species generated in the reaction medium", explains Prof. Fañanás". The formation of an intricate network of hydrogen bonds around the iron atom sustains the photocatalytic reactivity required to activate the alkane, while simultaneously suppressing the catalyst's tendency to undergo competing chlorination reactions. This creates an optimal environment

for the selective allylation reaction to proceed". In simpler terms, the catalyst carefully manages highly reactive radical intermediates so they drive the desired transformation without causing unwanted side reactions. Beyond its chemical precision, the method also stands out for its environmental advantages. It relies on iron, which is inexpensive, widely available, and far less toxic than the rare and precious metals often used in catalytic chemistry. The reaction runs under relatively mild temperatures and pressures and is powered by LED light. Together, these features reduce energy demands and environmental impact. This discovery was a part of a larger research effort supported by the European Research Council (ERC) aimed at upgrading the primary components of natural gas into more valuable chemicals. Converting natural gas into flexible chemical intermediates could expand industrial options and gradually decrease reliance on traditional petrochemical feed stocks.

www.sciencedaily.com; February 27, 2026

ENVIRONMENT

Ocean bacteria team up to break down biodegradable plastic

Biodegradable plastics could help alleviate the plastic waste crisis that is polluting the environment and harming our health. But how long plastics take to degrade and how environmental bacteria work together to break them down is still largely unknown.

Understanding how plastics are broken down by microbes could help scientists create more sustainable materials and even new microbial recycling systems that convert plastic waste into useful materials. Now MIT researchers have taken an important first step toward understanding how bacteria work together to break down plastic. In a paper published in *Environmental Science & Technology*, the researchers uncovered the role of individual ocean bacteria in the breakdown of a widely used biodegradable plastic. They also showed the complementary processes microbes use to fully consume the plastic, with one microbe cleaving the plastic into its component chemicals and others consuming each chemical. The researchers say it's one of the first studies illuminating specific bacterial species' role in the breakdown of plastic and indicates the speed of plastic degradation can vary widely depending on a few key factors."There is a lot of ambiguity about how long these materials actually exist in the environment", says lead author Marc Foster, a Ph.D. student in the MIT-WHOI Joint Program". This shows plastic biodegradation is highly dependent on the microbial community where the plastic ends up. It's also dependent on the plastics—the chemistry of the polymer and how they're made as a product. It's important to understand these processes because we are trying to constrain the environmental lifetime of these materials".

Foster further said "It's really rare for a single bacterium to carry out the full degradation process because it requires a significant metabolic burden to carry all of the enzymatic functions to depolymerize the polymer and then use those chemical subunits as a carbon and energy source". Other studies have sought to capture the molecular footprints of groups of bacteria as they degrade plastic, which gives a snapshot of the species involved without uncovering the mechanisms of action. For this study, the researchers wanted to uncover the roles of specific bacterial species as they fully degraded plastic. They started with a type of biodegradable plastic known as an aromatic aliphatic co-polyester. Such plastic is used in shopping bags and food packaging. It's also often laid across the soil of farms to prevent weeds and retain moisture. To begin the study, researchers at BASF, which produces that type of plastic, first placed samples of the product into different depths of the Mediterranean Sea to let bacteria grow as a thin biofilm around the plastic. The company then shipped the samples to researchers at MIT, who isolated as many species of bacteria as possible from the samples. The researchers mixed those isolates and identified 30 bacterial species that continued to grow in abundance on the plastic. Using carbon dioxide as a measure of plastic degradation, the researchers isolated each bacterium and found one, Pseudomonas pachastrellae that could depolymerize the plastic compounds breaking them into the three chemical components of the plastic: terephthalic acid, sebacic acid and butanediol. But that bacterium couldn't consume all three components on its own. One by one, the researchers exposed each bacterium to each chemical, finding no bacteria that could consume all three, although they did find some species that could consume one or two chemicals on their own. Finally, the researchers selected five bacterial species based on their complementary breakdown abilities and showed the small group exhibited the same ability to fully degrade the plastic as the 30-member bacteria community. "It was able to minimize the degradation process to the simplistic set of specific metabolic functions", Foster says. "And then when one bacterium was taken out, the mineralization dropped, which indicated the organism was controlling the degradation of the polymer. Then, when there was just one of the bacteria alone in a culture, none of them could reach the same degradation as all five together, indicating there was this complementary function required. It worked much better than it was visualized". The researchers also found the five-member bacteria community couldn't mineralize a different plastic, showing groups of bacteria may only be able to mineralize specific plastics. Foster noted that the bacteria in his study were likely specific to the Mediterranean Sea. The study also only involved bacteria that could survive in his lab environment. Still, Foster says it's one of the first papers that identifies the roles of bacteria in consuming plastic. Foster says the work is an important first step toward creating microbial systems that are better at breaking down plastic or converting it into something useful. In follow-up work, it is being explored what makes successful bacterial pairs for faster plastic consumption and how enzymes dock on plastic particles to initiate and continue degradation

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Distinguished Visitors to the Centre

Dr. H.R. Mahadewaswamy, Vice Chancellor, JSS University, Noida, India; and **Dr. B. Manoj Kumar**, Principal, JSS Academy of Technical Education (JSSATE), Noida, India

Dr. Livleen K. Kahlon, Director and Senior Fellow of the Environment Education and Awareness Division, The Energy and Resources Institute (TERI), New Delhi, India

Prof. Venugopalan Ittekkot, Former Director, Leibniz Center for Tropical Marine Research (ZMT), University of Bremen, Germany

Meetings and Visits of Director General, NAM S&T Centre

Meeting with Dr. R. Harikumar, Director, Energy Management Centre (EMC), Thiruvananthapuram, Kerala, India

Dr. Amitava Bandopadhyay, Director General along with Mr. Sunil Kumar, Accounts Manager, NAM S&T Centre visited Cochin, Kerala to attend the International Energy Festival of Kerala (IEFK) 2026 and also to sign a Memorandum of Understanding (MoU) with Energy Management Centre (EMC), Kerala. During the visit on 8 February 2026, Dr. Bandopadhyay had a detailed discussion with Dr. R. Harikumar, Director, EMC; Mr. Dinesh Kumar A. N., Joint Director, EMC; and other senior officials.

During the meeting, Dr. Bandopadhyay briefed Dr. Harikumar about current activities of the centre. It was also decided to hold an International Workshop during the IEFK 2027, to be jointly organised by EMC and NAM S&T Centre. The tentative theme of the Workshop was also discussed. A tentative topic for the proposed workshop was also suggested – "*Policies and Governance in Achieving Net Zero through ESG Frameworks: Challenges and Perspectives in the Global South*". However, the proposed topic will be further discussed by both sides before finalisation. Dr. Bandopadhyay also requested the EMC officials to initiate preparation of a joint Fact File.

Meeting with H. E. Mr. Sanjiv Ranjan, Secretary General, Indian Ocean Rim Association (IORA) Secretariat, Ebene, Mauritius

Dr. Amitava Bandopadhyay, Director General along with Mr. Sunil Kumar, Accounts Manager, NAM S&T Centre met His Excellency Mr. Sanjiv Ranjan, Secretary General, Indian Ocean Rim Association Secretariat (IORA) at the office of the IORA Secretariat on 26 March 2026 to discuss matters of mutual interest with regard to S&T Collaboration and also to sign the extension of Memorandum of Understanding (MoU) between the two organisations. Senior officials and staff members of IORA Secretariat were present during the meeting.

Dr. Bandopadhyay briefed the Secretary General about the current activities of the Centre in the areas of international scientific events (Workshops/Training Programmes/Conferences), Joint Fellowship Programmes and publications of Books/Monographs/Fact Files etc.

The possibility of organising a Joint International Workshop in Mauritius in September 2026 in physical mode was discussed in detail. The Secretary General assured Dr. Bandopadhyay that he will discuss the matter internally and convey the thematic areas soon so that the planning process may be initiated.

Subsequently, the Secretary General conveyed IORA's willingness to organise a 3-day Joint International Workshop in Mauritius in September 2026 on the broad Theme - *"Education in the Context of Emerging Technologies: Challenges, Opportunities and Way Forward"*.

Centre Announces

FOUNDATIONS OF SCIENCE DIPLOMACY: A TRAINING PROGRAMME FOR EARLY AND MID-CAREER RESEARCHERS

21-23 June 2026, Cape Town, South Africa

We live in a world where the boundaries between science, society and international relations are increasingly interconnected. Many of the most pressing challenges of our time, including climate change, pandemics, food and water security, energy transitions and the governance of emerging technologies such as artificial intelligence, transcend national borders and require coordinated international responses. These issues are not purely scientific or technical problems. They are also deeply political, social and diplomatic in nature. Addressing them requires new forms of dialogue that integrate scientific knowledge into the complex processes of policymaking and international cooperation.

Science diplomacy has emerged as an important mechanism at the intersection of science, policy, and international relations. In an increasingly interconnected and multi-polar world, science diplomacy plays a critical role in ensuring that global decision-making is informed by credible evidence while fostering constructive international partnerships. Early-and-mid-career researchers are often at the forefront of generating knowledge relevant to global and regional policy challenges. Yet many researchers have limited opportunities to understand how policy processes operate, how scientific advice informs international negotiations, or how they themselves can engage effectively at the science policy interface.

In view of the above, the Centre for Science and Technology of the Non-Aligned and Other Developing Countries (NAM S&T Centre), New Delhi, in partnership with the International Science, Technology and Innovation Centre for South-South Cooperation under the auspices of UNESCO (ISTIC), Malaysia; the Future Earth Africa Hub Leadership Centre (FEAHLC), South Africa; the National Research Foundation of South Africa (NRF), South Africa; and the University of Venda, South Africa, announces the organisation of "**Foundations of Science Diplomacy: A Training Programme for Early and Mid-Career Researchers**" during **21-23 June, 2026** in **Cape Town, South Africa**.

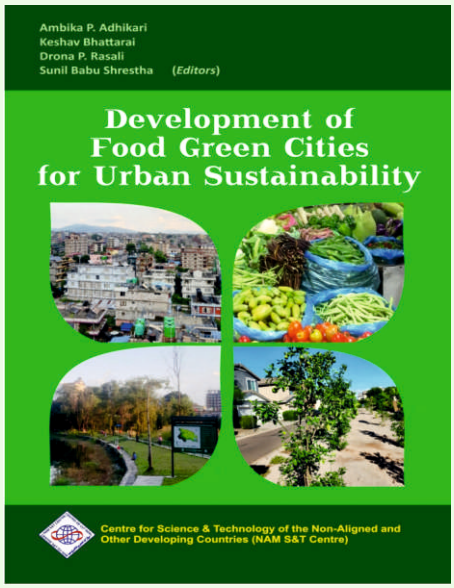
The Training Programme is expected to strengthen science diplomacy awareness and capacity building among early-and-mid-career researchers from Africa and the Global South. Participants will develop practical skills in communicating science for policy, negotiating across disciplines and sectors, and engaging with international cooperation mechanisms. It will also foster a growing network of emerging researchers committed to advancing science diplomacy and evidence based decision making in their respective countries and institutions.

Scientists and experts desirous of participating in the Training Programme, **except those from South Africa**, should submit their applications **electronically** to the Director General, NAM S&T Centre, New Delhi at email: namstcentre@gmail.com as early as possible but latest by **20 May 2026.** Applicants from South Africa should however submit their requests directly to: isticsecretariat@istic-unesco.org with a subject line as "***NAM S&T Centre – ISTIC – FEAHLC – NRF – UNIVEN Training Programme for EMCRs, 21-23 June 2026***".

For further details, please visit Centre's Website: www.namstct.org

New Publication

Development of Food Green Cities for Urban Sustainability



With rapidly growing urban populations, shrinking green spaces and increasing climate vulnerabilities, the idea of "Food Green Cities" have emerged as a critical option for rethinking how cities manage land, food systems, wastes and ecosystems. The concept of Food Green Cities emphasizes the integration of food production within urban environment to create self-sustaining and resilient communities. Ultimately, Food Green Cities foster social inclusion and community engagement while strengthening urban sustainability. Considering the importance of the subject, the *Centre for Science and Technology of the Non-Aligned and Other Developing Countries (NAM S&T Centre), New Delhi, India* has brought out a book titled **"Development of Food Green Cities for Urban Sustainability"**.

The edited volume comprises 16 comprehensive chapters, contributed by researchers, academicians and practitioners from various developing countries. Collectively, these chapters provide a multi-dimensional perspective on the evolving concept of *Food Green Cities*, addressing themes such as urban agriculture, rooftop gardening, waste management, composting, climate change adaptation, sustainable food systems, urban forestry, digital innovations and ethno-botanical applications for better urban health and resilience. This book aims to advance understanding and practice in developing sustainable, self-reliant and climate-resilient urban ecosystems. It is a valuable reference for policymakers, urban planners, researchers and practitioners who are working towards achieving the goals of urban sustainability and food security in the developing world.

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