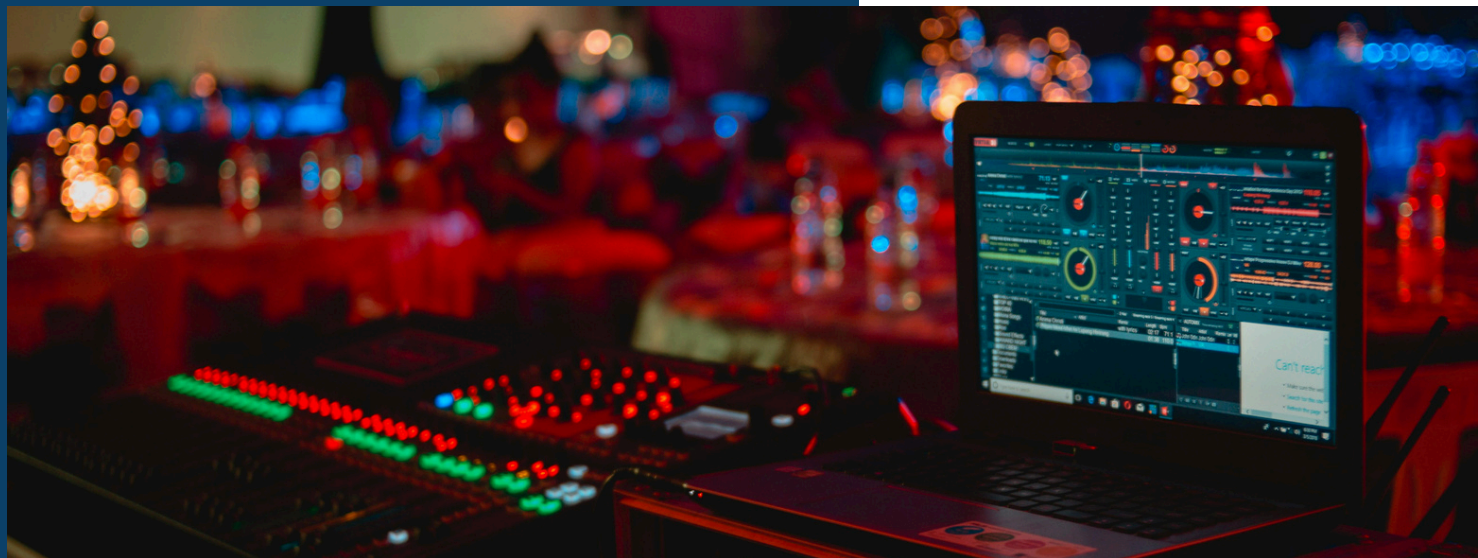


SCI & TECH PULSE

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Top News

- India's for Debris-Free Space Missions
- A New Test Kit to Diagnose Pulmonary Tuberculosis at Early Stage
- World Moving Towards First Pandemic Agreement
- New Scientific Discoveries to Cure Neurodegenerative Diseases

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Where is the World Moving – Scientific Breakthroughs: 2024

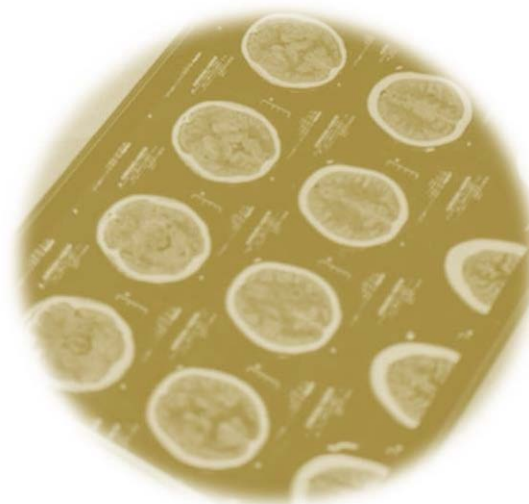
There are evidences that numerous scientific breakthroughs with potential to impact human lives and environment have taken place over the last few years. Many of these have been compiled and documented. In this connection, CAS Science Team, a division of the American Chemical Society, has come out with a list of top scientific breakthroughs in 2024 across industries pertaining to chemical sector. These breakthroughs appear to have capacity to significantly impact lives and livelihood of people and the sustainability paradigm of the world. Major areas of scientific breakthroughs are briefly discussed below.



Progress Towards Ending Cancer

Countries and research institutions all over the world have been making efforts towards new medicine to cure cancer. In this regard, the immuno-oncology, the

study of how our immune systems normally interact with cancer cells and tumors, has seen tremendous progress in the last few years. Evidences suggest that newly approved medicine such as cytokines, vaccines, tumor-directed monoclonal antibodies, and immune checkpoint blockers continue to grow in market size. Further, novel therapies [like TAC01-HER2] are currently undergoing clinical trials. This unique therapy uses genetically engineered autologous T cells, that recognize human epidermal growth factor receptor 2 (HER2) presence on tumor cells to remove them. This could be a promising therapy for metastatic, HER2-positive solid tumors.



Another promising strategy aims to use the CAR-T cells against solid tumors in conjunction with a vaccine that boosts immune response. Immune boosting helps the body create more host T cells that can target other tumor antigens that CAR-T cells cannot kill.

Another notable progress is in the development of improved and effective personalized therapies. For instance, a recently developed personalized RNA neoantigen vaccine, based on uridine mRNA-lipoplex nanoparticles, was found effective against pancreatic ductal adenocarcinoma. However, several challenges remain, including the fact that immuno-oncology are therapy resistance, lack of predictable biomarkers, and tumor heterogeneity. It is expected that research institutions would focus on devising novel treatment strategies in the times to come.

Decarbonizing Energy

Over the last few years, several efforts have been made by various countries to decarbonize energy production by replacing fossil fuel-based energy sources with sources that generate no (or much less) CO₂ in 2024.



One such effort is to incorporate large-scale energy storage devices into the existing power grid. These are an important part of enabling the use of renewable sources since they provide additional supply and demand for

electricity to complement renewable sources. Several types of grid-scale storage that vary in the amount of energy they can store and how quickly they can discharge it into the grid are under development. Some are physical (flywheels, pumped hydro, and compressed air) and some are chemical (traditional batteries, flow batteries, supercapacitors, and hydrogen). It is predicted that solutions in the latter category will continue to be the subject of active chemistry and materials development research in 2024.

Increasing Role of AI in R&D

AI is increasingly penetrating various facets of our lives and manufacturing



processes. However, as of now, gains from the AI's integration to chemistry and drug discovery is yet to be fully realised. This is changing now. In the recent periods, generative AI is impacting drug discovery, and machine learning is being used more in environmental research, and large language models like ChatGPT are

being tested in healthcare applications and clinical settings.

A significant development in integrating AI has occurred recently. DeepMind¹ and Isomorphic Labs² have recently come out with a new model which is capable of showing improved accuracy, can generate predictions for almost all molecules in the Protein Data Bank, and expand coverage to ligands, nucleic acids, and posttranslational modifications. Other popular developments in the field include Therapeutic antibody discovery driven by AI, and platforms such as the RubrYc Therapeutics antibody discovery engine which are expected to help advance research in this area.

In the coming time, a continuous improvement is inevitable with AI, and thus, we can expect to see many new developments and innovations throughout 2024.

News in India

Artificial Intelligence

India's Generative AI Landscape: A Decade Ahead in Innovation

India is realising an extraordinary transformation in its technological

landscape, fueled by the rapid rise of generative AI. The country's burgeoning GenAI ecosystem is a testament to its innovative spirit and technological prowess with a vibrant landscape of startups, substantial investments, and a wealth of skilled talent.

The Generative AI capabilities we are witnessing today are ahead of their time, at least by 10 years. This observation is made by the CEO, CloudThat. As per media reports that the number of GenAI startups has doubled between 2021 and 2023. These startups focus on various sectors, including code & data, marketing, and education. The AI sector has attracted substantial funding, exceeding \$440 million since 2019. The majority of this investment flowed in 2022, highlighting investor confidence in the technology.

This extraordinary transformation is supported by India's large pool of skilled engineers and researchers, contributing to the rapid pace of innovation in the field. Leading research institutions and universities in India are actively involved in GenAI research, pushing the boundaries of the technology, combined with active research in leading institutions, further

¹ DeepMind Technologies Limited, doing business as Google DeepMind, is a British-American artificial intelligence research laboratory. It has come out with AlphaFold, an AI system that predicts a protein's 3D structure

from its amino acid sequence. It regularly achieves accuracy competitive with experiment.

² Isomorphic Labs was established in 2021 to apply AI and computational methods to drug discovery and to transform the way medicine helps and heals people.

solidifies its position as a thriving hub for GenAI advancement.

The pace of AI innovation in India is accelerating rapidly. While it currently accounts for approximately one percent of the global AI market, it's expected to experience the second-fastest growth rate among major economies over the next five years, just behind China. Indian companies are increasingly adopting AI solutions across various sectors, from healthcare and finance to manufacturing and retail. This is fueled by a growing recognition of AI's potential to improve efficiency, reduce costs, and drive innovation.

GenAI has been absorbed across industries. For instance, sector-agnostic solutions are dominating the Indian GenAI landscape, with 81 products designed to cater to a wide array of industries. Early adopters like IT, marketing, and education are already leveraging GenAI for tasks ranging from content creation and code generation to personalized learning experiences. Emerging applications are also gaining traction, with GenAI proving its value in sectors like healthcare (medical imaging analysis), finance (fraud detection), and agriculture (crop yield prediction).

Generative AI's Impact on Enterprises has been monumental as it is contributing to improved productivity and efficiency; enhanced customer experience; new revenue streams; and competitive advantage.

The road ahead for Generative AI development in India is brimming with potential and promises transformative advancements across various sectors. With a burgeoning tech-savvy population and increasing digital penetration, the adoption and growth of Gen AI are set to accelerate exponentially. One of the most promising aspects is the potential economic impact. Gen AI is projected to significantly boost India's GDP, adding billions of dollars by 2030 and potentially trillions in cumulative impact over the next few years.

India in Space

India's for Debris-Free Space Missions

India has come out with an initiative to achieve debris-free space missions by all Indian space actors, governmental and non-governmental by 2030. India also encourages all other state space actors to follow this initiative for the long-term sustainability of Outer Space.



India intends to bring to the notice of the international community and other State

space actors to encourage them to join this initiative. Department of Space will ensure space missions with Zero Debris (termed Debris Free Space Missions – DFSM) by all Indian Space actors, governmental and non-governmental by 2030 through meticulous design and execution of important guidelines.

Towards achieving the DFSM, following necessary steps are planned to be taken:

- a) Avoid debris generation during the operational life of satellites and launch vehicles as well as during the post-mission disposal phase
- b) Avoid on-orbit collision and break-up of satellites and launch vehicles through necessary failure mode studies, redundant systems and mission design with high reliability,
- c) Avoid intentional break-ups with long-lived debris
- d) Comply with the Post-mission disposal (PMD) of spent orbital stages and satellites with a success probability of more than 99 percent. Ensure either controlled re-entry or de-orbiting to a lower orbit with less than 5 years remaining orbital life for rocket bodies and spacecraft at their end of operational life.

This intent also ensures that by 2030 all satellite and launch vehicle missions will be planned and operated taking into account the following:

- a) Special considerations for human spaceflight safety – Considering 400

km +/- 30 km band as the orbital band for human space missions by avoiding minimum orbital transfers in this band by space missions

- b) Ensuring trackability, identifiability, and maneuverability of all satellites throughout the mission phases
- c) Recommending all Spacecraft mission extensions only after critical consideration of system health, safety and system readiness for post-mission disposal
- d) Coordination and data sharing, at National and International levels, for safe and sustainable operations

This intent will ensure the necessary Capacity Building for space object tracking and monitoring and also progress in concerted efforts for Space Debris Research on innovative techniques for the long-term sustainability of outer space activities.

The implementation of this DFSM initiative will start by the beginning of 2025 by making efforts at the mission planning and design level for launch vehicle and spacecraft missions by selecting orbital slots considering the collision threats in the orbital bands, fuel budgeting for post-mission disposals, mission trajectory planning with necessary controlled re-entry or de-orbiting and also considering the reliability aspects. Annual progress will be evaluated on the implementation of the DFSM, the ISRO system for safe and sustainable space operations management (IS4OM) will be the nodal

point in implementing the DFSM with the support of other entities of the Department of Space.

The long-term goal matches with the theme “Join Together for a Safe, Secured and Sustainable Space, Preserve the Common Heritage of Humankind for Future Generations, Space for all & for all generations”.

Healthcare - India

A New Test Kit to Diagnose Pulmonary Tuberculosis at Early Stage

A new test kit to diagnose pulmonary tuberculosis has been launched on 8th April 2024 virtually by Dr. V.K. Saraswat, President of SCTIMST and member NITI Aayog. The Sree Chitra Tirunal Institute for Medical Sciences and Technology (SCTIMST) in Trivandrum has developed this new test kit that can diagnose pulmonary tuberculosis at an early stage. This innovative technology has been licensed to M/S Agappe Diagnostics, Kochi.



SCTIMST developed this kit as an open platform system to provide affordable,

fast, and accurate diagnosis of pulmonary tuberculosis. Following successful independent validation, the Central Drugs Standard Control Organization (CDSCO) has approved the kit for manufacturing and commercialisation. This TB kit can be used in any qPCR machine, which means that the existing COVID-19 testing infrastructure established during the pandemic can be utilized for tuberculosis screening on a large scale. Tuberculosis (TB) is a communicable disease that causes the highest number of deaths globally. Approximately 1.8 billion people in the world are affected by TB. Unfortunately, the COVID-19 pandemic has worsened the situation, resulting in a 3.6 percent increase in the incidence of the disease since 2020. In India, the incidence of TB is 193 cases per 100,000 people in 2022, and in Kerala, it is 67 cases per 100,000 people. The World Health Organization (WHO) aims for India to have less than 50 cases per 100,000 as an immediate target.

The major challenge in the TB eradication program is the lack of a highly accurate and affordable population-level screening tool to identify missing cases. The newly developed AG Chitra TB diagnostic kit has an accuracy of 97.71 percent. The technology has been developed as an open platform, avoiding the need for proprietary machines to amplify DNA. The PCR testing centres established during the COVID-19 pandemic can now be repurposed for TB diagnosis

using this kit. The sample-to-result time is around one hour. This low-cost, indigenously developed kit could revolutionize early detection of tuberculosis.

News from the World

World Health Organisation

World Moving Towards First Pandemic Agreement

Less than three years back in December 2021, the World Health Assembly, the decision-making body of WHO, met in a Special Session, and decided to establish the Intergovernmental Negotiating Body (INB) to draft and negotiate a WHO convention, agreement, or other international instrument on pandemic prevention, preparedness and response. Towards this, the INB has conducted nine meetings so far with the last meeting ending in March 2024. The process has involved participation of other United Nations system bodies, non-state actors, other relevant stakeholders, and the public.



This ninth meeting of the Intergovernmental Negotiating Body

(INB9) started on 18 March and ended on 28 March 2024. During the meeting, government negotiators discussed all articles from the draft agreement, including adequate financing for pandemic preparedness, equitable access to medical countermeasures needed during pandemics and health workforce strengthening. Furthermore, WHO Member States agreed to resume negotiations aimed at finalizing a pandemic agreement during April-May 2024. The decision followed two weeks of intensive country-led discussions on critical subjects aimed at making all countries of the world better prepared for, and able to effectively and equitably respond to, future pandemics.

The members of the WHO are expected to consider the proposed text of the world's first pandemic agreement for adoption during the Seventy-seventh World Health Assembly, starting 27 May 2024. As per the draft agreement, the objective of the WHO Pandemic Agreement, guided by equity, and the principles and approaches set forth herein, is to prevent, prepare for and respond to pandemics.

The draft agreement also mentions that to achieve the objective of the WHO Pandemic Agreement and to implement its provisions, the Parties will be guided, inter alia, by the principles of a) full respect for the dignity, human rights and fundamental freedoms of all persons, and the enjoyment of the highest attainable standard of health of

every human being; b) the sovereign right of States to adopt, legislate and implement legislation, within their jurisdiction, in accordance with the Charter of the United Nations and the general principles of international law, and their sovereign rights over their biological resources; c) equity as the goal and outcome of pandemic prevention, preparedness and response, ensuring the absence of unfair, avoidable or remediable differences among groups of people; d) common but differentiated responsibilities and respective capabilities in pandemic prevention, preparedness, response and recovery of health systems; e) solidarity, transparency and accountability to achieve the common interest of a more equitable and better prepared world to prevent, respond to and recover from pandemics; and f) the best available science and evidence as the basis for public health decisions for pandemic prevention, preparedness and response.

Environment and Climate Change

Reducing Environmental Impact of Chemical Processes

Increasing efforts are now being made seeking innovative ways to minimize the environmental impact of chemical processes. CAS Scientific breakthroughs data reveal that several developments have occurred in the recent part that can help reduce environmental impact of chemical processes. Here are emerging

areas witnessing significant breakthroughs:

- Reducing plastics: More than 350 million tons of plastic waste are generated every year. Across the landscape of manufacturers, suppliers, and retailers, reducing the use of single-use plastics and microplastics is critical. New value-driven approaches by innovators like MiTerro that reuse industrial by-products and biomass waste for eco-friendly and cheaper plastic replacements will soon be a reality. This is expected to reduce costs and plastic footprints throughout the entire supply chain.
- Alternative battery chemistry: In the battery and energy storage space, finding alternatives to scarce “endangered elements” like lithium and cobalt is be critical. While essential components of many batteries, they are becoming scarce and expensive. Evidences suggest that new investments in lithium iron phosphate (LFP) batteries that do not use nickel and cobalt have expanded. It is expected that this new product will capture 45 percent of the EV market share by 2029. Furthermore, continued research is projected for more development in alternative materials like sodium, iron, and magnesium, which are more

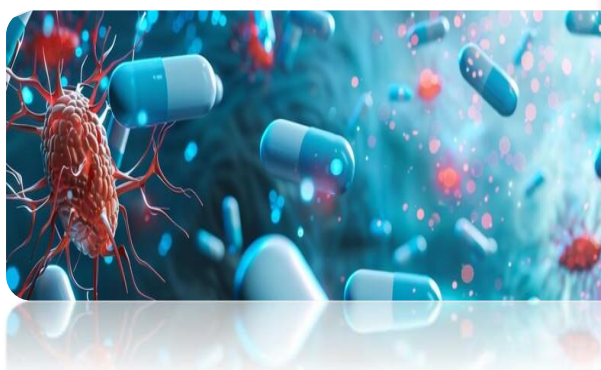
abundant, less expensive, and more sustainable.

- Recycling lithium-ion batteries (LIB): Lithium-ion recycling has witnessed increased investments with more than 800 patents already published in 2023. The use of solid electrolytes or liquid nonflammable electrolytes may improve the safety and durability of LIBs and reduce their material use. Finally, a method to manufacture electrodes without solvents could reduce the use of deprecated solvents such as N-methylpyrrolidinone, which require recycling and careful handling to prevent emissions.

Healthcare - World

New Scientific Discoveries to Cure Neurodegenerative Diseases

Neurodegenerative diseases are a major public health concern, being a leading cause of death and disability worldwide. While there is currently no cure for any neurodegenerative disease, as per CAS, some progress has been achieved in the recent times in this direction.



- Alzheimer's disease: Two immunotherapeutics have received FDA approval to reduce both cognitive and functional decline in individuals living with early Alzheimer's disease. Aduhelm received accelerated approval in 2021 and is the first new treatment approved for Alzheimer's since 2003 and the first therapy targeting the disease pathophysiology, reducing beta-amyloid plaques in the brains of early Alzheimer's disease patients. Another medicine Leqembi received traditional approval in 2023 and is the first drug targeting Alzheimer's disease pathophysiology to show clinical benefits, reducing the rate of disease progression and slowing cognitive and functional decline in adults with early stages of the disease.
- Parkinson's disease: New treatment modalities outside of pharmaceuticals and deep brain stimulation are being researched and approved by the FDA for the treatment of Parkinson's disease symptoms. The non-invasive medical device, Exablate Neuro (approved by the FDA in 2021), uses focused ultrasound on one side of the brain to provide relief from severe symptoms such as tremors, limb rigidity, and dyskinesia. 2023 brought major news for Parkinson's disease research with the validation of

the biomarker alpha-synuclein. Researchers have developed a tool called the α-synuclein seeding amplification assay which detects the biomarker in the spinal fluid of people diagnosed with Parkinson's disease and individuals who have not shown clinical symptoms.

- Amyotrophic lateral sclerosis (ALS): In this area, two companies have seen FDA approval in the past two years to slow disease progression in individuals with ALS. Relyvrio was approved in 2022 and it acts by preventing or slowing more neuron cell death in patients with

ALS. Tofersen (Qalsody), an antisense oligonucleotide, was approved in 2023 under the accelerated approval pathway. Tofersen targets RNA produced from mutated superoxide dismutase 1 (SOD1) genes to eliminate toxic SOD1 protein production. Recently published genetic research on how mutations contribute to ALS is ongoing with researchers recently discovering how NEK1 gene mutations lead to ALS. This discovery suggests a possible rational therapeutic approach to stabilizing microtubules in ALS patients.



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