Annexure-XX

Celebration of Science Week
Delhi 2025

WOMEN IN STEM

91st INSA Anniversary

2nd - 5th December 2025

IWA, an INSA initiative

Abstract Book

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Miranda House
UNIVERSITY OF DELHI

MESSAGE BY PRINCIPAL MIRANDA HOUSE

PROF. BIJAYALAXMI NANDA
Principal
Miranda House
University of Delhi
New Delhi

It is a matter of great honour that Miranda House, University of Delhi, is a hosting partner for the upcoming INSA Science Week, to be held in Delhi from 2–5 December 2025. As part of this national celebration of scientific education, Miranda House is privileged to host the Induction Ceremony of the newly introduced INSA Women Associates on 5 December 2025. This new vertical of INSA is a landmark initiative aimed at recognizing, encouraging, and amplifying the contributions of outstanding women scientists across the country.

The INSA Science Week provides a vibrant platform for dialogue, collaboration, and inspiration across diverse scientific disciplines. Participants—ranging from faculty members and researchers to students—will have the opportunity to engage with eminent scientists and interact with transformative ideas shaping the future of scientific research in India. The inclusion of the Induction Ceremony of the INSA Women Associates adds a powerful dimension to this celebration, underscoring the academy's commitment to gender equity and the creation of a more inclusive scientific ecosystem.

This collective celebration of science gains further depth through the participation of esteemed academic and research institutions, each contributing unique strengths, perspectives, and innovations. As we come together for this significant event, we are reminded of the responsibility shared by the scientific community to nurture talent, promote innovation, and strengthen collaborative networks that support meaningful scientific advancement.

I applaud the efforts of the organizing teams at INSA and Miranda House for curating this important programme and creating a space where scientists, educators, and students can connect, exchange ideas, and build a foundation for future breakthroughs. Hosting the INSA Women Associates Induction Ceremony at Miranda House aligns seamlessly with our institution's legacy of empowering women and fostering excellence in science.

On behalf of Miranda House, I extend my warmest wishes for a successful and inspiring INSA Science Week. May this gathering of brilliant minds lead to fresh insights, impactful collaborations, and collective progress in the pursuit of scientific knowledge.
With warm regards,

Professor Bijayalaxmi Nanda
Principal
Miranda House
University of Delhi
New Delhi

MESSAGE BY INSA PRESIDENT

PROF. ASHUTOSH SHARMA
President
Indian National Science
Academy Bahadur Shah Zafar Marg
New Delhi

The year 2025 marks a moment of exciting transformation for the Indian National Science Academy (INSA). Building on the Academy's long-standing commitment to excellence, INSA has reimagined its traditional Annual General Meeting as a week-long Celebration of Science to be held from 2–5 December 2025 across leading Delhi–NCR institutions, including Indian Institute of Technology Delhi, Jawaharlal Nehru University, Ashoka University Sonipat, Amity University Noida, University of Delhi, ICAR-Indian Agricultural Research Institute, Miranda House DU, and SRM-Institute of Science and Technology Ghaziabad. This step, moving the AGM beyond a single campus and into a city-wide Science Week, is an important institutional reform intended to broaden public engagement, strengthen university–academy partnerships, and bring science closer to society.

The programme has been thoughtfully designed to showcase the full spectrum of scientific endeavour in India. It combines the core elements of the AGM: the Council Meeting, the residential Address, the induction of newly elected Fellows, and the felicitation of outgoing Council members with an expanded series of sectional meetings, distinguished lectures, and public-facing events. These activities will take place across partner institutions and will feature lectures and presentations by newly elected Fellows, INSA Young Associates, Associate Fellows, the History of Science Young Associate, and the INSA Women Associates. The event will also include sessions highlighting science in translation and science for society. We view this Celebration of Science as more than a logistical change: it is a deliberate effort to democratize the Academy's outreach and to invite a wider community of students, educators, policy- makers, industry partners, and the general public into conversations about the impact of science on national development. By decentralizing the AGM and situating sessions at multiple universities and research institutes, we hope to foster fresh collaborations, engage diverse audiences, and inspire the next generation of scientists. I warmly invite all members of India's scientific community and all those who value science-led progress to participate in the

Celebration of Science. Together we will celebrate achievements, reflect on the evolving role of science in society, and renew our commitment to evidence-informed policy and inclusive scientific endeavour. May this week reinforce INSA's mission of nurturing excellence, broadening engagement, and advancing the role of science for the public good.

With warm regards,
Professor Ashutosh Sharma
President
Indian National Science Academy

MESSAGE BY INSA EXECUTIVE DIRECTOR

Dr Brajesh Pandey
Executive Director
Indian National Science Academy
Bahadur Shah Zafar Marg
New Delhi

This year, for the first time, the Academy's Annual General Meeting will expand into a four-day *Celebration of Science*, from December 2 to 5, 2025, hosted across major institutions in the Delhi–NCR region. Partner campuses include IIT Delhi, Jawaharlal Nehru University, Ashoka University, Amity University, University of Delhi, ICAR-IARI, Miranda House, and SRM-IST Ghaziabad. This city-wide initiative is a key institutional effort aimed at deepening public engagement, strengthening collaboration with universities, and fostering closer connections between science and society.

The Celebration will integrate the AGM's core functions—Council Meeting, Presidential Address, induction of Fellows, and recognition of outgoing members—while offering an expanded programme of sectional meetings, distinguished lectures, and events for broader audiences. Newly elected Fellows, INSA Young Associates, Associate Fellows, and INSA Women Associates will present their work, along with sessions focused on science for society and science in translation. More than a logistical change, this initiative aims to open the Academy's doors to students, educators, policymakers, industry professionals, and the public, fostering meaningful dialogue and collaboration. By dispersing activities across multiple institutions, we aim to inspire young minds, foster partnerships, and promote science-led national progress.We warmly invite the scientific community and all supporters of evidence-based development to participate in this Celebration of Science and join us in reaffirming INSA's mission—excellence, inclusion, and science for public good.

With warm regards,
Dr Brajesh Pandey
Executive Director
Indian National Science Academy

Aparajita Bhattacharya
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Leadership through Architecture: from Specification to Silicon

Abstract

From powering 99% of the world's smartphones to advancing into data centers and high performance computing, Arm architecture has become a foundational pillar of the modern digital world. Behind this global impact lies a journey rooted in collaboration, resilience, and a shared vision—one that closely parallels my own professional path and the remarkable rise of Arm India.

I began my career as a young engineer at Arm's small Austin Design Center, contributing to the development of the first high-performance Arm CPU—technology that helped spark the smartphone revolution. A few years later, I moved to the fledgling India Design Center, then a modest group of junior but highly motivated engineers, determined to build capability and earn trust across the global organization.

Since then, Arm India has evolved into a vital hub of innovation and leadership. I have had the privilege of growing alongside it—starting as an engineer, helping to establish the Architecture and Technology group in India, and now leading the global engineering team within Arm's Architecture group. We contribute to the evolution of the Arm architecture, define specifications to ensure clarity and consistency, and develop verification solutions that help our partners implement the architecture correctly and confidently.

In this talk, I will reflect on how Arm's architectural vision—and Arm India's evolution—intertwine with my own journey. I will share insights into building trusted technology at global scale, and what it means to lead a worldwide organization from within the vibrant technology landscape of India.

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Productivity and Monsoon: Are they linked in Bay of Bengal?

Abstract

The Quaternary Period is an important interval in geological records as it marks many large amplitude and high-frequency oscillations which might have affected various biological parameters and terrigenous inputs in the bay. However, limited work has been carried out to study the monsoonal variation during Mid Pleistocene Transition (MPT) and post MPT and its effect on productivity with respect to change in glacial cycle. Here, we present an integrated study of organic– inorganic geochemistry and micropaleontology from western Bay of Bengal (IODP U1446, offshore Mahanadi basin) ~1.3 Ma to decipher productivity changes.

Overall, productivity proxies show a shift towards higher values post MPT. The variability in the productivity proxies shows that stronger Indian monsoon post MPT created stronger stratification during interglacials leading to lower biological productivity in the region. The stronger glacial post MPT induced convective mixing resulting in high nutrients and also the glacial monsoonal event owing to Southern Hemispheric (SH) forcing further added nutrients to the study site enhancing productivity in the glacial period. The high glacial-interglacial variability was the primary factor responsible for the shift in marine productivity across the MPT.

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Understanding Quick Wilt Resistance in Black Pepper: Insights from Molecular and Rhizobiome Studies

Abstract

Black pepper (*Piper nigrum* L.), known as the "King of Spices," is economically significant in India but is severely affected by quick wilt disease caused by *Phytophthora capsici*. To explore the molecular basis of this plant–pathogen interaction, we analyzed disease-responsive genes and regulatory small RNAs such as tRNA-derived fragments, rRNA-derived small RNAs, and long non-coding RNAs. As developing stable resistance in cultivated black pepper is challenging, examining beneficial root-associated microbes pursued a sustainable, farmer-friendly approach. Comparative rhizobiome profiling of a susceptible cultivar and its naturally resistant wild relative, *Piper colubrinum*, using 16S rRNA amplicon sequencing and shotgun metagenomics, revealed clear differences in bacterial diversity. Notably, *P. colubrinum* possessed a higher abundance of known biocontrol taxa. These findings suggest that harnessing beneficial microbiomes offers a promising, environmentally safe strategy for managing quick wilt disease.

In parallel, studies were conducted on Type III polyketide synthases (PKSs) from *Aegle marmelos*, *Phyllanthus emblica*, and *Zingiber officinale*. Notably, work on *A. marmelos* led to the identification and functional characterization of a PKS responsible for quinolone biosynthesis. Structural analysis of this enzyme uncovered previously unrecognized catalytic features that govern the formation of pharmacologically important secondary metabolites, providing new insights into PKS-mediated natural product biosynthesis.

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Thermodynamic insights into nucleic acid binding of phytochemicals

Abstract

For decades, the phenomenon of plant-derived small molecules binding to DNA has grown in interest. Many of such phytochemicals belong to the indole alkaloid group with effective medicinal properties. Nucleic acids (mainly DNA) are the main molecular target of many of these ligands because of their vast pharmaceutical applications. Transcription or replication may be impacted by these interactions, which may ultimately result in apoptotic cell death. Here, we describe the DNA binding interactions of several bioactive indole alkaloid compounds, such as yohimbine, harmane, ajmalicine, etc, with a special emphasis on their thermodynamic aspects. Calorimetric, multi-spectroscopic and molecular modelling techniques have been employed under physiological conditions, to estimate the binding thermodynamics. The Scatchard plot analyses using the McGhee-von Hipple method revealed non-cooperative binding and affinities in the range of 10^5- 10^6 M^{-1}, either with 1:1 or 1:2 stoichiometry. Thermodynamic analyses suggested spontaneous, exothermic binding, favored by negative enthalpy and positive entropy changes in most of the cases. The interaction between the phytochemical and DNA was majorly governed by non polyelectrolytic forces. The results of iodide quenching, urea denaturation assay, dye displacement, circular dichroism and *in silico* molecular docking, revealed the groove binding natures of all the ligands (under investigation, towards DNAs). Both biophysical and computational methods were used to validate the groove binding mechanism. The thermodynamic profile and structural features discussed here could help create new DNA targeted treatments with reduced side effects and increased efficacy.

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Towards the sustainable synthesis of active pharmaceutical ingredients (APIs) for affordable healthcare

Abstract

Organic chemistry research involves development of new and more efficient reactions and catalysts, recreating complex molecules found in nature such as bioactive compounds in the lab, with a wide range of applications in medicine, materials science, and energy. Organic Chemistry has undergone transformations beyond the imagination of the early chemists: the functional properties and complexity have been the two driving factors in choosing targets for synthetic organic chemists. The primary demands of academia have been to "somehow" reach the target molecule whereas the industry demands were mostly on the scalability and adaptability for mass production at the lowest cost possible. The pharma and agro industries, with large volumes of effluents and by-products, have got criticism from the masses while the products have changed the way we live including the quality of life. To overcome this criticism and also to minimize the adverse impacts on the environment, the experimental organic chemistry has begun a new innings following quality by design in industry and ideal synthesis in academic efforts. Our group has been engaged both in academia driven work and industry related projects and realised the contrast in approaches. A mixed strategy satisfying the demands of academia, industry and environment is adapted and our learnings will be shared. Herein, we present an overview of recent developments in the synthesis of few bioactive/API molecules.

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From 2D to 3D: Functional Spheroid Models Shaping the Future of Anti-Cancer Drug Development

Abstract

This study presents a 3D lung cancer spheroid model that closely mimics the tumour microenvironment for more reliable cancer research. Lung adenocarcinoma, one of the most common and deadly cancers, requires better models to test new therapies. The 3D spheroids were created to replicate tumour growth, necrosis, and drug response. Cellular assays provided insights into mechanisms of tumour progression and metastasis as well as confirmed apoptosis in spheroids treated with anticancer agents. Additionally, the presence of hypoxia and EMT-related markers, as well as the angiogenic potential observed in the spheroids highlighted the relevance of these assays for consideration by the regulatory agencies as alternative-to-animal tools for evaluation of newer anti-cancer agents.

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Nutritional Biochemistry, Functional Foods, and Agri-ResearchLeadership

Abstract

Advances in nutritional biochemistry and functional food research are central to addressing global challenges of malnutrition, metabolic disorders, and micronutrient deficiencies. Food Matrix Lab's body of work exemplifies this integrationbyexploring the molecular dynamics of food matrices, bioactive compounds, and nutrient bioavailability to inform next-generation agri-derived innovations. The research spans metabolic pathway engineering, glycemic response modeling, and characterization of phytochemicals and micronutrients across cereals, legumes, and mushrooms. Through interdisciplinary leadership, Food Matrix Lab, bridges fundamental science with translational outputs, contributing to commercialized technologies, improved crop nutritional profiles, and nutraceutical development. The efforts highlight the critical role of agri-research leadership in shaping sustainable, health-focused food systems for emerging global needs.

R. John
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Molecular Basis of Cold Hardiness: Lessons from Himalayan Plants for Crop Improvement

Abstract

Plants inhabiting the Kashmir Himalayan region exhibit remarkable resilience to extreme environmental stresses, providing a unique opportunity to unravel the molecular and physiological mechanisms underlying stress tolerance. Our research focuses on dissecting these adaptive strategies using an integrated multi-omics framework that combines genomics, transcriptomics, proteomics, metabolomics, and physiological analyses. We investigate a range of Himalayan high
altitude species along with *Brassica rapa*, *Brassica oleracea*, and diverse maize germplasm to understand how cold, light, and other abiotic factors regulate growth, development, and reproductive transitions. A major component of our work examines flower development in *Brassica rapa*, where we have identified key temperature- and light-responsive proteins associated with floral initiation and morphogenesis.

In collaboration with ICGEB, the Indian Institute of Maize Research, Delhi University (South Campus), SKAUST, and international partners through Indo-German and Indo-US initiatives, we integrate fundamental molecular insights with applied breeding strategies. Current research efforts focus on identifying and validating the functional alleles that govern cold tolerance through QTL mapping, GWAS, haplotyping, and CRISPR/Cas9-based genome editing. By leveraging natural and doubled-haploid maize populations derived from crosses between the cold-resilient Gurez Local and elite cultivars, we aim to develop pre-breeding lines suitable for temperate and high
altitude agro-climatic regions.

Additionally, our work explores plant adaptation across altitudinal gradients to link ecological traits with molecular signatures of stress resilience. Overall, this research advances our understanding of cold tolerance mechanisms and aims to translate Himalayan plant hardiness into climate-smart crop improvement, contributing to sustainable agriculture in cold and marginal environments.

Sarika Jalan
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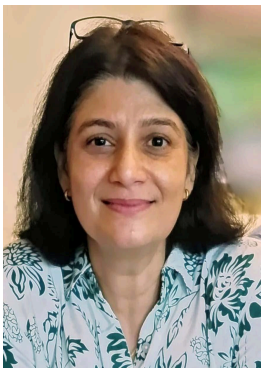
A world of higher-order interactions: Beyond pairwise

Abstract

Many real-world systems—from social groups to neural circuits—depend on interactions that happen in groups rather than just pairs. My research shows how these higher-order interactions fundamentally change the way collective behaviour emerges, spreads, and stabilizes. By looking at groups as the basic units of interaction, we uncover hidden phenomena that traditional network models miss. A key result of my work is the revelation of a nontrivial finite-size scaling in higher-order dynamical systems, where critical thresholds and stability regimes depend sensitively on network size. Higher-order coupling introduces size dependent nonlinear corrections that persist even beyond the mesoscopic scale. This discovery helps explain why experiments, simulations, and real-world systems often do not match predictions that assume infinitely large networks.



Prof. Sharmistha Banerjee
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Many Lives, Many Masters: Cellular Heterogeneity in Regulation of Human Immunodeficiency Virus-1 Infection Cycle

Abstract

Human Immunodeficiency Virus-1 (HIV-1) primarily targets immune cells, including T lymphocytes, macrophages, and dendritic cells; however, it can also infect glial, neuronal, and astrocytic cells during chronic infection. These cell types support variable viral replication; brain cells, such as astrocytes (reservoirs), permit minimal proliferation, whereas CD4+T lymphocytes are more productive. Characterizing reservoirs is vital, as they sustain HIV-1 persistence and rebound viremia, complicating therapy and cure efforts. We investigate cell specific factors and mechanisms that regulate HIV-1 persistence, driving latency, rapid spread, or abortive infection. We specifically study nucleocytoplasmic trafficking of viral components and analyze molecular distinctions to advance understanding of HIV biology, guiding therapeutic strategies (PLOSONE-2013; Retrovirology-2014; JMB-2020; Viruses-2021; FEBS-J-2022; JVI-2023; Front.Immunol-2024; Traffic-2025).

One of our recent discoveries elucidates that HIV-1 Tat interferes with a host protein, hnRNPA2, to disrupt RNA splicing in CD4+T-lymphocytes, but not in astrocytes. This change affects the production and movement of viral RNA, influencing virus titers, positioning hnRNPs as novel antiviral factors. We also discovered that new virus particles pick up different host proteins depending on the cell they come from, which changes the infectivity of the emerging viruses. For example, viruses from CD4+T-lymphocytes package Importin β-1, which helps them enter the nucleus and infect new cells. However, if Importin β-1 is already present in high amounts, it can block HIV replication after the virus has integrated into the genome. This dual functionality highlights the dynamic conflicts between host defense and viral adaptation, providing novel insights into intrinsic innate immune mechanisms.

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Designing greener energy conversion system for a sustainable future

Abstract

Global energy requirements are touching new meridians with the gradual advancement in the living standards and the day-by-day growing world population. This necessitates the exploration to seek for greener and sustainable energy reservoir systems which ought to be environmentally agreeable for such an intriguing purpose. Electrochemical energy conversion and storage devices offer some most alluring aptitudes for providing clean energy. To name a few of these include fuel cells, rechargeable metal
air/peroxide batteries and HCl/ H_2S electrolysis and likewise.[1,2] Oxygen being central to the processes in these devices, a lot of attention has been focused upon the study of oxygen chemistry in terms of oxygen reduction reaction (ORR) and also Hydrogen evolution reaction (HER) and thence to the melioration of the associated electrocatalysts. In the past decade research has depicted tremendous improvement towards the betterment of fuel cells/metal-air/peroxide batteries/hydrogen production in its legions of shortcomings or corrigible features.[3,4] But still an infinite pursuit towards the exploration of effective, sturdy and energy efficient catalysts continues. The talk addresses,

• several strategies pursued to replace noble-metal free electrocatalysts for ORR/HER. • Zn based batteries

• visualization of local electrocatalytic activity by SECM.

Keywords: ORR, HER, electrocatalyst, Zn based batteries, SECM

Prof. Vandana Nanal
Tata Institute of Fundamental Research, Mumbai

Is neutrino its own antiparticle?

Abstract

The nuclear beta decay revealed the existence of neutrino more than eight decades ago, but the neutrino still continues to be a puzzle waiting to be unravelled. The mass and nature of neutrinos play an important role in physics beyond the standard model. At present, neutrinoless double beta decay (NDBD) is perhaps the only experiment that can tell us whether or not the neutrino is its own antiparticle. Given the significance of the NDBD, there is a widespread interest worldwide employing a variety of novel techniques. This talk will present a brief report of ongoing and proposed NDBD experiments and will highlight Indian efforts towards the feasibility study of search for NDBD in 124Sn.

Professor Sheffali Gulati
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Understanding autism spectrum disorder: Pathophysiology and current research insights

Abstract

Autism Spectrum Disorder (ASD) is a multifactorial neurodevelopmental condition marked by deficits in social communication, restricted interests, and repetitive behaviours. Its pathogenesis involves complex interactions among genetic, epigenetic, environmental, and neurobiological factors that disrupt brain development and neural connectivity. Genetically, ASD arises from rare and common variants, CNVs, and de novo mutations in genes like SHANK3, CHD8, and NRXN1. Aberrant DNA methylation adds to its variability, while global genomic studies are uncovering pathogenic mechanisms and clinical correlations. Neurodevelopmental abnormalities include disrupted neurogenesis, faulty neuronal migration, excitatory-inhibitory imbalance, and impaired synaptic pruning. Neuroimaging reveals atypical brain connectivity, early overgrowth, and volumetric changes in the frontal and temporal lobes, cerebellum, and corpus callosum, offering potential diagnostic biomarkers. Environmental factors such as maternal infections, advanced parental age, valproate exposure, toxins, and nutrient deficiencies increase ASD risk through inflammatory and epigenetic mechanisms, while neuroinflammation and microglial activation impair synaptic development. Common comorbidities include intellectual disability, epilepsy, ADHD, sleep and psychiatric disorders, and metabolic or endocrine dysfunctions, underscoring the need for multidisciplinary care. Biomarkers like oxidative stress indicators, AGEs, heavy metals, and mitochondrial dysfunction aid early detection. Management is focussed on early behavioural therapy, complemented by gene therapy, probiotics, dietary changes, TMS, and pharmacological approaches. AI-driven diagnostic tools, digital platforms, and community-based therapies enhance early screening and personalized care. Integrating genetic, environmental, and metabolic insights through large-scale, longitudinal research will advance precision medicine, early intervention, and global ASD management.

Mohanty Sujata
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Regenerating Hope, Celebrating Science: Stem Cells Unleashed

Abstract

Regenerative medicine and stem cell research offer significant promise for the treatment of a wide range of degenerative diseases, providing potential solutions for tissue repair and cellular regeneration. Stem cells can build every tissue in the human body, and hence have great potential for future therapeutic uses in tissue regeneration and repair. They have the ability of unlimited self-renewal to produce progeny the same as the originating cell and the ability to differentiate into a specialized adult cell type. With the increase in incidences of disease related to the cornea, skin, bone, heart, and liver tissue, there is an emerging need to develop an off-the-shelf alternate approach as a part of regenerative tissue engineering to help in tissue regeneration.

Mesenchymal stem cells (MSCs) are a promising therapeutic tool in regenerative medicine due to their multipotency, immunomodulatory properties, and ability to secrete extracellular vesicles (EVs) that facilitate tissue repair and regeneration. MSCs exhibit added advantages: secretion of a variety of tropic factors, maintaining natural microenvironment, highly proliferative, improved survival and anti-inflammatory properties, better response to cellular signals, facilitate vascularization *in vivo,* and exhibit enhanced regeneration potential. Additionally, they produce extracellular vesicles (EVs), and a multitude of cytokines and growth factors that suppress immune responses that allow allogenic MSCs to be used for tissue regeneration.

In skin tissue regeneration, MSCs and their EVs have shown promising results in promoting wound healing, reducing scar formation, and enhancing epithelialization and angiogenesis. In ocular injuries, MSCs have been demonstrated to promote corneal epithelial regeneration and reduce inflammation, offering a potential therapeutic avenue for treating corneal injuries and

dry eye disease. Additionally, MSC-derived EVs play a pivotal role in tissue engineering, where they contribute to the enhancement of scaffold-based tissue regeneration. Notable clinical trials have investigated the use of MSCs & their EVs in the treatment of chronic wounds, corneal injury, and cartilage defects, demonstrating their potential to improve healing and functional recovery. While the clinical evidence is promising, further large-scale, well-controlled trials are necessary to establish optimal protocols for EV-based therapies. With ongoing advancements and a deeper understanding of their mechanisms, EV-based therapies have the potential to revolutionize the treatment of various medical conditions, pushing the boundaries of current clinical practices and offering new hope for patients.

Keywords: Mesenchymal Stem Cell, Extracellular vesicles, Regeneration

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Epigenetic insights into neurodegeneration: Role of 5-hydroxymethylcytosine in REM sleep deprivation

Abstract

Rapid eye movement sleep deprivation (REMSD) induces stress that disrupts normal brain function, leading to significant neurological defects and cognitive dysfunction, similar to those observed in neurodegenerative and behavioral disorders like Alzheimer's disease (AD) and Amyotrophic lateral sclerosis (ALS). Although these conditions are multifactorial and result from complex interactions between genetic and environmental factors, the specific mechanisms by which sleep deprivation, especially REMSD, contributes to neurodegeneration remain largely unclear and insufficiently explored. 5-hydroxymethylcytosine (5-hmC), one of the various epigenetic mechanisms, has gained attention for its role in the regulation of gene expression within the central nervous system (CNS). Although 5-hmC is highly enriched in the brain, its specific involvement in sleep deprivation-related neurodegeneration remains largely unexplored.

Using hMeDIP sequencing, we have identified significant genome-wide alterations in 5-hmC patterns within the brain tissue of REMSD rats. These differentially hydroxymethylated regions are associated with genes related to neuronal development, memory, learning, neurotransmission, synapse and cognitive functioning, processes commonly disrupted in neurodegeneration. Notably, several of these affected genes encode RNA-binding proteins (RBPs) that are known for their pathological roles in neurodegenerative disorders. The co-occurrence of 5-hmC alterations with dysregulated expression and aggregation of RBPs suggests a mechanistic link between sleep loss and neurodegeneration. Collectively, our findings highlight the interplay between an altered DNA hydroxymethylation landscape and RBP dysfunction in REMSD-associated neurodegeneration.

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Science, Strategy, and Stewardship: Shaping Leadership for a Viksit Bharat

Abstract

As India advances towards the vision of *Viksit Bharat*, science, technology, and innovation must become the foundation of this national transformation. Achieving this goal calls for leadership that blends scientific excellence, strategic foresight, and social stewardship. This lecture explores how India can cultivate a new generation of leaders who drive discovery, foster collaboration, and ensure that science serves as a catalyst for both national development and global good.

Central to this transformation is a strong partnership between industry and academia, where ideas are translated into impact through co-created research, applied innovation, and commercialisation of indigenous technologies. This collaborative approach bridges the gap between knowledge and implementation, positioning India as a global hub for responsible and sustainable innovation.

Inclusive innovation must also remain a cornerstone of progress. Expanding access to scientific opportunities, empowering marginalised communities, and increasing women's participation in STEM are essential steps in ensuring that technological advancement benefits every segment of society.

Leadership within the scientific ecosystem must evolve from competition to collaboration, from hierarchy to mentorship, and from ambition to stewardship. By nurturing integrity, empathy, and curiosity alongside intellect, India can foster leaders capable of building sustainable solutions that address global challenges.

In this journey from vision to realisation, science must anchor national strategy, and leadership must embody stewardship. Only through this integration can India shape a *Viksit Bharat* that is scientifically strong, socially inclusive, and globally respected.

Research Focus

This lecture focuses on the intersection of science, leadership, and innovation policy in shaping India's journey toward becoming a developed nation. It examines structural and cultural shifts required within scientific and academic institutions to foster collaboration, ethical leadership, and inclusivity.

Keywords : Science policy; innovation leadership; Viksit Bharat; inclusive innovation; STEM participation; industry–academia collaboration; sustainable development

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Quantum Resource Theories

I will give an overview of quantum resource theories emphasizing their role in quantum foundations and technologies.

Dr D. Joshi
Co-founder and CEO, VigyanShaala International

Finding Your Tribe and Shaping the Future Together

Abstract

Science and technology have given humanity extraordinary power. But, the true question is not what the world can do, it is what kind of world we choose to build. As we stand at the crossroads of climate change, inequality, and rapid technological transformation, the challenge before us is as moral as it is scientific.

In this talk, Dr Darshana Joshi invites young minds, especially women in STEM, to dream beyond individual success, to see themselves as co-architects of a shared sustainable future. She will introduce the '3I Approach – Inclusive, Innovative, and Interdisciplinary' as a framework for solving the complex challenges of our time, from climate resilience to equitable access to technology. Drawing on her journey from a Delhi government school to the University of Cambridge, and on VigyanShaala's work empowering thousands of young women in STEM across India, she explores how "finding your tribe" can spark courage, collaboration, and purpose.

Dr Joshi will challenge the audience to push boundaries and then push them a little more as they envision science not just as a tool for progress, but as a shared language of empathy, justice, and hope.

Because the only thing bigger than where you will be in five years is where the world will be and together, we can shape it for the better.

Dr. Rupa Vasudevan
Chancellor & Founder, Bharatiya Engineering Science and Technology Innovation University (BESTIU), Andhra Pradesh, India

Reimagining the Indian HEI as a Global Node

Abstract

Indian higher education is rapidly evolving into a global node—an open, networked ecosystem where learners, researchers, and industry collaborate to co-create knowledge across borders.

Future-ready HEIs will adopt co-creator and co-learner models while leveraging AI-driven personalised learning pathways, advancing the concept of an "omniversity" that transcends geographical boundaries.

BESTIU's "Living Lab" and "Innovation Immersions" exemplify how technology, local innovation, and global engagement can enable experiential, cross-border learning. By aligning skills with emerging job markets through agile, industry-responsive frameworks, Indian universities can transform into transnational hubs shaping talent, research, and solutions for a rapidly changing world.

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A journey of two decades: Building an enterprise for antibodies

Abstract

Bioklone Biotech Private Limited, founded in 2006, is a Contract Research Organization that specializes in the development of customized antibodies and assays. It has over 500 clients across various sectors including academia, R&D divisions of hospitals, diagnostic and pharma companies, in India and abroad. Bioklone has successfully developed custom antibodies to over 1000 antigens including proteins, peptides, polysaccharides, drugs, small molecules and whole cells. The company offers end-to-end services, including peptide designing, expression and purification of recombinant proteins, development of antibodies in rabbits and mice, purification and labelling of antibodies and development of assays for the antibody users. Bioklone has vast experience in the development of pharmacokinetic (PK) and anti-drug antibody (ADA) assays for study and assessment of new biosimilars and drug candidates as well as in vitro assays using cell-lines to study cell viability/proliferation.

The key to Bioklone's success is its scientific and innovative approach in the execution of all the projects. This has been possible because of the experienced technical team at Bioklone, which pays attention to finer details and executes the projects with unerring precision. Bioklone's antibodies and services have been cited in several international publications. The company is known as a reliable antibody partner who is vested in the success of its projects. Despite the struggles and challenges in antibody development and validation, Bioklone continuously strives to adhere to its commitment and quality, even if it has to go the extra mile.

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Delivering Hope: Getting RNA Medicines to the Right Place in the Cell

Abstract

Every disease begins with a message inside our cells that has gone off script. Those messages are written in RNA - the quick notes that tell a cell what to make and when. Traditional drugs often act from the outside, easing symptoms but missing the source. RNA medicines are different: they can correct the faulty message itself, opening doors to problems long considered "undruggable" and bringing fresh hope to patients.

The hurdle is the last mile. RNA is delicate. If it doesn't reach the right spot inside the cell, it won't help. Think of delivery as the difference between a letter and a letter that actually reaches the right address.

In this talk, I'll share a simple, visual story of GEENIE™ - a tiny protein helper we're building to act like a courteous guide, protecting RNA on the journey and walking it past cellular barriers to the place where it can work. This kind of precision could mean smaller doses, fewer side effects, and real options for hard problems in the brain, in the eye, where today's tools often fall short.

Beyond experiments, this work is a story of curiosity, compassion, and courage - bridging cell biology, chemistry, and protein engineering, and linking teams across India and Ireland. I invite students to pursue meaningful questions, speak across disciplines, and persist until science becomes care. Breakthroughs don't end at discovery; they begin when we deliver healing, responsibly and at the right place - leaving a legacy of lives made better.

Dipti Kakkar Thukral
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Former Adviser, Anusandhan National Foundation (ANRF), New Delhi

Role of women scientists in shaping the future of women in STEM in India

Abstract

Women scientists in India have played a transformative role in shaping the country's scientific landscape and in advancing opportunities for future generations of women in STEM. Their contributions span cutting-edge research, leadership in national laboratories, policy formulation, innovation-driven entrepreneurship, and impactful mentoring. This talk highlights the multifaceted influence of women scientists—from pioneering figures who laid the foundation for women's participation in science to contemporary leaders driving India's progress in frontier areas such as Nanotechnology, biotechnology, space science, artificial intelligence, and environmental sustainability.

Despite persistent structural and societal barriers, women scientists have continually challenged norms, expanded representation, and championed more inclusive scientific ecosystems. Their leadership has strengthened national programs supporting women's careers, including targeted fellowships, re-entry grants, flexible working environments, and mentorship. Through community engagement, science communication and advocacy, they have also inspired young girls to pursue scientific paths, bridging gaps in aspiration and access.

The talk examines key initiatives and success stories that showcase how women scientists contribute not only through their scientific achievements but also through systemic change—promoting gender equity, supporting interdisciplinary collaboration, and shaping policy frameworks that ensure sustained participation of women in STEM. By reflecting on their journeys, challenges, and strategies for empowerment, the session aims to envision a future where women's talent and leadership form an essential pillar of India's scientific growth. Ultimately, the role of women scientists extends beyond personal accomplishment; it catalyzes a more inclusive, innovative, and resilient scientific ecosystem for India's future.

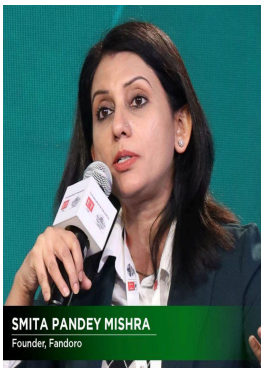
Dr. Alka Sharma
Additional Director General
Extramural Research
Indian Council of Medical Research
Ministry of Health and Family Welfare

Cell and Gene Therapy: *Futuristic Therapies* Opportunities, Challenges, and the Road Ahead

Abstract

Gene therapy offers an innovative and transformative approach for development of cutting-edge therapies for various diseases including genetic disorders, cancers, and autoimmune diseases. Globally, several transformative cell and gene therapies are being developed. In India, cell and gene therapy interventions are moving forward at a fast pace due to the increased ability to initiate and carry out novel cutting-edge research. Overall aim is to develop these therapies affordable in India. Clinical trials of gene therapy in humans have shown some success in treating certain diseases such as severe combined immune deficiency, Hemophilia, retinitis pigmentosa and Leukemia. In Hemophilia, gene therapy aims to provide the body with the ability to produce the clotting factor that patients are lacking which would be useful in reducing the need for blood transfusion for maintaining Facto-VIII levels. Cellular therapy such as CAR-T therapy exemplifies how immune engineering can convert a patient's immune system into a precise anti-cancer weapon. Indigenous CAR-T therapies in academic-industry partnership have also been developed in India that would help in reducing the cost by several fold. However, developing cost effective models for scale-up; manufacturing; evolving regulatory pathways; and long-term follow up frameworks require strengthened institutional support. Several challenges need to be addressed before full scale advantage of these technologies can be made available to the patients. Some of them includes: safely and off-target effects; affordability; infrastructure/facility for indigenous largemanufacturing for clinical trial material generation; development of scalable process, globally accepted clinical trial protocols and product/cell banks. Monogenic disorders are likely first targets for widespread gene therapy

rollout.Academic-hospital integration strengthens clinical translation. This would also be required appropriate regulatory framework, investment, and manufacturing scale-up.



Smita Mishra

Rewriting the Code of Responsibility: From Business to AI to Planet

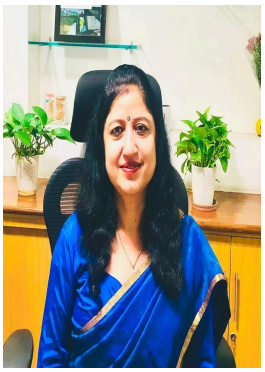
Abstract

As the world is working towards concluding COP30 and the 2030 Sustainable Development Goals (SDGs) deadline, a quiet revolution is underway — one that is not just about technology or policy, but about responsibility.

This talk explores how responsibility is emerging as the new currency of trust — across businesses, investors, and intelligent machines. From responsible business practices that measure impact beyond profit, to responsible AI that thinks ethically, to responsible investors who steer capital toward sustainability — we are witnessing the formation of a new ecosystem where value meets values.

• How AI can be a force for good — if built on fairness, transparency, and inclusivity.
• Why ESG and SDGs are not corporate buzzwords but design principles for the next generation of entrepreneurs.
• How responsible investing is reshaping the global economy and redefining growth.
• What COP30 and the global stock take mean for young innovators entering this decade of action.

Through the lens of Fandoro Technologies, we'll reimagine how AI, finance, and sustainability can converge to create not just smart enterprises — but wise ones.
The talk invites students to think of themselves not as future employees or founders, but as architects of responsible intelligence — where every idea, code, and company contributes to a regenerative, inclusive, and sustainable planet.



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Building an Inclusive and Sustainable STI Ecosystem at the Grassroots

Abstract

Science, Technology and Innovation (STI) at the grassroots level plays a transformative role in addressing local challenges, enhancing livelihoods, and fostering inclusive development. By leveraging local knowledge systems alongside scientific and technological advances, grassroots innovations can offer sustainable solutions in areas such as agriculture, health, energy, water management, and climate resilience. A strong STI ecosystem at this level not only empowers communities but also strengthens national innovation capacity by ensuring that technological progress reaches the last mile.

The evolving STI landscape in India increasingly demands a collaborative approach—bringing together government agencies, academia, industry, startups, and local communities. Such convergence enables the co-creation and deployment of context-specific technologies, fosters entrepreneurship, and accelerates technology diffusion. Emerging technologies such as artificial intelligence, drones, and biotechnology are reshaping the innovation ecosystem, creating new opportunities for problem-solving and scaling grassroots innovations through digital platforms and data-driven decision-making.

The way forward lies in building stronger institutional linkages between central and state systems, promoting participatory innovation models, and enhancing the capacity of State S&T Councils and local innovation hubs. Policy coherence, sustained funding, and inclusive frameworks that integrate science with social needs will be key to realizing an equitable and resilient STI ecosystem—one that transforms grassroots ingenuity into scalable, sustainable national progress.

Evaluating the Optimized Use of TiO_2 Nanoparticles in Promoting Microalgal Growth of *Chlorella* and *Scenedesmus* Species: Current Findings and Future Perspectives

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Abstract

Nanoparticles with a very less in diameter shows distinctive physicochemical properties and large surface area that confer significant advantages for applications in medical, biotechnology, microbiology, pharmaceutics and chemistry, engineering, inexpensive catalyst, cytotoxicity study. Titanium dioxide (TiO_2 NPs) nanoparticles are widely studied due to their notable optical and photocatalytic characteristics. However, their influence on microalgal physiology beyond toxicity has not been well studied until now. The present study investigates the effects of different concentration of TiO_2 nanoparticles from 0 to 5 µL on the growth of two microalgal species, *Chlorella* sp. and *Scenedesmus* sp., commonly used in remediation of polluted water bodies like Yamuna. Over a 15-day culture period, *Scenedesmus* sp. showed maximum growth under nanoparticle-free control medium and growth gradually decreasing as TiO_2 concentrations increased. However, *Chlorella* sp. shown in a growth as concentration-increase, achieving maximal optical density at 3 to 5 µL TiO_2, signifying a stimulatory effect at moderate to elevated nanoparticle levels. These divergent, species-specific responses highlight the potential for modifying TiO_2 nanoparticle dosages to increase microalgal growth and thereby enhance the phycoremediation efficiency. Subsequent investigations will focus on the integration of TiO_2 nanoparticle-mediated growth promotion within algal-based wastewater treatment systems to optimize contaminant removal.

Keywords: *Chlorella* sp., nanoparticle, phycoremediation, *Scenedesmus* sp, Titanium dioxide

Effect of Different Concentrations of Amoxicillin on Pollen Germination and Pollen Tube Elongation of *Catharanthus roseus*

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Abstract

Environmental contamination by pharmaceutical antibiotics has become an emerging ecological concern, yet their specific effects on early plant reproductive processes remain insufficiently explored. This study examined how varying concentrations of amoxicillin influence pollen germination and pollen tube elongation in *Catharanthus roseus*, a medicinally valuable species with dependable in-vitro pollen viability. Fresh pollen grains were exposed to graded amoxicillin solutions prepared in Brewbaker and Kwack medium and germination percentage along with pollen tube length were quantified using microscopy and micrometry to capture dose-dependent responses. The results showed a clear concentration-linked decline : control pollen exhibited robust germination and long, healthy tubes; low concentrations caused minimal or no inhibition; moderate concentrations significantly reduced germination and tube growth; and high concentrations led to strong suppression and many ungerminated grains. These patterns suggest that amoxicillin disrupts membrane stability and early developmental pathways, revealing its potential to impair plant reproduction under pharmaceutical pollution. Overall, the study highlights a pressing need to monitor antibiotic contaminants in urban and agricultural ecosystems, as even routinely used drugs may exert subtle but impactful effects on plant health and ecological balance.

Keywords : Amoxicillin, Pollen Germination, Pollen Tube Elongation, *Catharanthus roseus*, Brewbaker and Kwack Medium

Phytoremediation potential of *Lemna minor* in Removing Cationic and Anionic Synthetic Dyes: An Integrative Research Review

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Abstract

The textile industry is one of the largest contributors to water pollution. It releases effluents containing synthetic dyes, heavy metals, and other toxic compounds. Their complex aromatic structures make the synthetic dyes resistant to degradation. Conventional treatment methods like flocculation, adsorption, photolysis and membrane filtration are effective, but they are expensive and often create secondary pollution in the form of sludge. Because of these limitations, phytoremediation has become an eco-friendly alternative for dye removal. Phytoremediation utilizes the natural pollutant-removal capacity of plants. It has gained prominence as a viable green technology. Among aquatic macrophytes, Duckweed (*Lemna minor*) is a free-floating macrophyte found in fresh water and sewage, is an ideal candidate in wastewater treatment due to its higher growth rate and proven ability to absorb various pollutants, heavy metals, and organic compounds. This integrative review utilizes findings from recent studies (2020-2025) to evaluate the phytoremediation potential of *L. minor* for removing structurally distinct cationic and anionic textile dyes. A systematic literature search was conducted across scientific databases like ScienceDirect, Scopus, SpringerLink, and Google Scholar which reveals that *L. minor* shows higher removal efficiency for cationic dyes as compared to anionic dyes due to strong electrostatic attraction between positively charged dye molecules and negatively charged plant surfaces. Various mechanisms like biosorption onto root surfaces, rhizofiltration, phytostabilization and the gathering of metals into plant tissues that were identified. Despite strong laboratory-scale evidence, key research gaps still persist. The interactions within a mixed-dye system can be antagonistic or synergistic, and these effects are poorly understood for *Lemna minor*. In order to proceed to the next step of practical application future research on the topic will be more focused on validation at a pilot scale, studying plant-microbe interactions, developing multispecies phytoremediation approaches and carrying out the mechanisms by using mixtures of dyes. Overall, *Lemna minor* stands out as an eco-friendly, low-cost, and large-scale candidate for phytoremediation, which can significantly help in resolving dye pollution issues in underdeveloped areas with no or poor wastewater treatment facilities.

Endosperm Balance Number: Driver of Seed Success

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Abstract

Seed development in flowering plants depends on the correct balance of maternal and paternal genomes in the endosperm, controlled by the Endosperm Balance Number, EBN. This balance is essential for viable seed formation, yet the developmental effects of EBN variation across species remain underexplored. This study aims to examine how differences in EBN influence endosperm development, seed viability, and hybrid success, and to evaluate whether EBN can guide the selection of compatible parents in breeding programs. A structured literature review was conducted using peer reviewed studies from 1990 to 2025 that reported EBN values, genome ratios, and developmental outcomes in interspecific and interploidy crosses. Across studies, balanced EBN ratios supported normal endosperm cellularization, nutrient distribution, and embryo growth. In contrast, mismatched EBN caused abnormal or delayed endosperm development, reduced seed size, and frequent seed abortion. These findings highlight EBN as a major driver of seed success and a practical tool for predicting hybrid compatibility. Understanding EBN diversity can help breeders avoid post-zygotic barriers and improve seed-based crop improvement strategies.

Keywords: Endosperm Balance Number, seed development, genomic ratio, hybridization barriers, plant breeding

In-Silico ADMET Analysis & Pharmacological Profiling of *Emilia sonchifolia*

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Abstract

Emilia sonchifolia is a widely used medicinal herb known for its anti-inflammatory, antimicrobial, and wound-healing properties, yet its phytochemical mechanisms remain scientifically underexplored. This study establishes the first integrated in-silico workflow to evaluate the plant's phytochemicals through ADMET screening, target prediction, molecular docking, and pathway mapping. A total of 82 reported compounds were catalogued from literature, and γ-muurolene, a sesquiterpene hydrocarbon, was selected as a representative model to demonstrate the computational pipeline. ADMET analysis indicated favourable drug-likeness, while pharmacophore-based target prediction and docking helped identify potential protein interactions and biological pathways. This approach provides a systematic foundation for understanding the bioactive potential of *E. sonchifolia* phytochemicals and supports future prioritization of compounds for experimental validation.

Keywords*: Emilia sonchifolia*, γ-Muurolene, ADMET, Molecular Docking, Pathway Mapping

The potential of organic farming in agroecosystem: It's future prospects and Challenges

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Abstract

This review explores the potential of organic farming in agro-ecosystems, acknowledging its role in improving soil health and biodiversity, while confronting significant challenges such as often lower yields (15-25% reduction) and climate stress. Global organic cultivation has expanded significantly, indicating a rising demand for environmentally friendly food. Emerging solutions, including the use of climate-resilient cultivars and bio-inputs like microbial consortia and biofertilizers, show potential to address nutrient limitations and enhance plant resilience. However, the combined impact of these integrated approaches is not well understood, which represents a key research gap. The study emphasizes that integrating stress-tolerant cultivars with effective, locally sourced bio-inputs could enhance productivity, soil health, and resilience in organic systems, suggesting a crucial pathway for long-term sustainability that requires further multi-location field validation.

Keywords: Organic farming, climate-resilient cultivars, bio-inputs, soil health, sustainability, agroecosystems.

Exploring Stress Memory in *Arabidopsis thaliana* Through Transcriptomics: Differential Gene Expression, Core Network Structure, and Epigenetic Signatures

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Abstract

Drought severely limits global crop productivity, yet the mechanisms by which plants coordinate early stress responses and retain stress memory remain poorly understood. We analyzed the *Arabidopsis thaliana* drought dataset GSE80744 from NCBI GEO, comparing control plants with 3-day (early) and 9-day (late) drought treatments using GEO2R ($|\log_2 FC| \geq 1$, $p \leq 0.05$). Analysis revealed that early drought predominantly induced lipid-transfer proteins, glycine-rich proteins, and cell-wall enzymes (XTH3). In contrast, prolonged drought activated strong ABA- and defense-associated genes, including RAB18, LEA29/46, ACD6, and PDF1.2A, along with repression of several ERF transcription factors. The top 40 significant DEGs were integrated into STRING to generate a Minimal Stress Network, revealing a tightly connected module linking transcriptional regulators (ERF016/017/018, DREB1F), ABA/LEA nodes, defense genes, and structural components. Reports suggest that several key hubs—such as DREB1F, RD29A, AZI1, and PDF1.2 family genes—undergo chromatin modifications during repeated drought, indicating their potential roles as epigenetic stress-memory candidates. This analysis establishes a connection between phased transcriptomic responses with network structure and provides a framework for the development of a quantitative Memory Index in future.

Keywords: Drought, Differential Gene Expression, Transcriptomics, STRING Network, Stress Memory, Epigenetics

Baseline Assessment of Carbon Storage across Vegetation types in an Urban Institutional Landscape

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Abstract

Institutional green spaces contribute meaningfully to local climate regulation, yet their vegetation-specific carbon storage remains largely unquantified. Since different species vary in size, growth patterns, and biomass, establishing baseline information is essential for understanding their role in CO_2 mitigation and for guiding climate-responsive ecological planning. The primary objective of this study is to establish an initial baseline understanding of how different tree species within an institutional landscape contribute to carbon storage and CO_2 uptake. This involves documenting the existing vegetation structure and exploring early patterns in species-wise carbon values using non-destructive measurements and modelling tools. The study aims to generate foundational data that can support future, more detailed analyses of biomass, soil organic carbon, and overall carbon sequestration potential as the work progresses. Tree parameters including species identity, diameter at breast height (DBH), height, canopy width, and overall condition were recorded. These measurements were analysed through the i-Tree Eco model to estimate preliminary CO_2 uptake and early carbon storage patterns. Further integration of shrub biomass, lawn dry matter, and soil organic carbon is planned. Initial patterns indicate that larger-girth, mature species such as *Ficus*, *Pongamia pinnata*, and *Eucalyptus* form the dominant early carbon pool, while fast-growing species like *Cassia fistula* and *Mangifera indica* show higher annual uptake despite moderate biomass. Continued analysis is expected to produce a comprehensive, component-wise carbon budget for the institutional landscape.

Keywords: Carbon storage; CO_2 sequestration; institutional vegetation; i-Tree Eco model; allometric traits; DBH; species-specific carbon uptake; baseline assessment.

Biochar-based microbial seed coating to alleviate drought stress in medicinally important *Tithonia diversifolia*

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Abstract

Drought stress poses a significant threat to global agricultural productivity, with nearly 70% of global land area projected to experience declining soil moisture by 2025. In 2023, approximately 48% of global land experienced at least one month of extreme drought conditions, threatening food security and medicinal plant cultivation worldwide. *Tithonia diversifolia* (Mexican sunflower), valued for its anti-inflammatory, antimalarial, antidiabetic, and antioxidant properties, requires innovative cultivation strategies to enhance resilience under water scarcity. This study explores biochar-based microbial seed coating as a sustainable approach to alleviate drought stress in *T. diversifolia* cultivation.

Biochar seed coating enhances seed germination, stand establishment, and plant growth under water-deficit conditions through multiple mechanisms. The porous biochar structure improves soil water retention, nutrient availability, and creates favorable microhabitats for beneficial microorganisms, while microbial inoculants enhance root development and stress-responsive gene expression. Recent evidence demonstrates that biochar coating promotes photosynthetic performance, stabilizes chloroplast ultrastructure, and maintains reactive oxygen species homeostasis under drought stress. For *T. diversifolia*, which typically requires 1,000-2,000 mm annual rainfall but tolerates 700-2,500 mm, this technique offers potential to expand cultivation into marginal lands while maintaining medicinal compound production. Integration of plant growth-promoting rhizobacteria (PRPR) with biochar carriers have reported enhanced nutrient uptake by 39% for nitrogen, 31% for phosphorus, and 34% for potassium under water-deficit conditions. This innovative approach represents a scalable strategy for enhancing *T. diversifolia* cultivation resilience against drought stress.

Keywords: Drought Stress, Biochar, PGPR, *T. diversifolia*

Apomictic reproduction: Is it opportunity or failure?

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Abstract

Sexual reproduction is the norm in flowering plants, but apomixis which is asexual seed formation without fertilization offers an alternative pathway. It can produce genetically identical offspring, ensuring trait stability across generations. However, the absence of genetic recombination raises questions about adaptability and long-term viability. Understanding apomixis has immense potential in agriculture for fixing hybrid vigor and reducing seed costs. It will address the question- Does apomictic reproduction represent an evolutionary advantage (opportunity) or a limitation (failure) for plant species and agriculture? The hypothesis states that apomixis serves as an opportunity rather than a failure, offering stability and efficiency for agricultural systems, though it may limit genetic diversity in natural populations. It is a literature -based review. Sources are Peer-reviewed journals, scientific databases (PubMed, Google scholar, etc.), and reports from 2000-2025. Apomictic reproduction is more of an opportunity than a failure, especially in the context of sustainable agriculture and food security. Future research should focus on transferring apomictic traits into crop species and managing the genetic stability-diversity balance.

Keywords: Apomixis, asexual reproduction, parthenogenesis, hybrid seed, plant breeding, genetic stability.

The Phytoremediation power of *Eichhornia crassipes*: A case study at the Yamuna – Najafgarh confluence

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Abstract

The Yamuna River is a critical freshwater resource in northern India, supporting urban, agricultural, and industrial needs. However, rapid urban expansion and uncontrolled discharge of untreated sewage and industrial effluents—especially through the Najafgarh drain have resulted in significant ecological degradation and water quality deterioration. This study explores the phytoremediation potential of *Eichhornia crassipes* (water hyacinth) to mitigate Pollution in this region. Water from the Najafgarh drain section was treated with *E. crassipes* across three replicates over a 7-day period. Changes in physicochemical parameters were monitored on Days 0, 2nd, 5th, and 7th, including pH, electrical conductivity, total dissolved solids, salinity, chloride, acidity, alkalinity, dissolved oxygen (DO), and biological oxygen demand (BOD). Results showed notable reductions in BOD, electrical conductivity, salinity, and total dissolved solids, along with a marked increase in dissolved oxygen. The pH tended towards neutrality, and both acidity and alkalinity levels decreased, indicating improved buffering. These findings demonstrate that *E.crassipes* is an effective, low-cost phytoremediation agent for reducing pollution in urban aquatic ecosystems.

Keywords: *Eichhornia crassipes*, phytoremediation, Yamuna River, Najafgarh drain, water pollution, aquatic macrophytes, water quality, dissolved oxygen

In *Silico* analysis of Plant Secondary Metabolites in Enhancing Symbiotic Association between *Lotus japonicus* and *Bradyrhizobium* nodulation genes through Molecular Docking and ADMET Profiling

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Abstract

This study investigates secondary metabolites from *Lotus japonicus* including flavonoids such as daidzein and isoflavonoids as chemical signals that enhance its symbiosis with *Bradyrhizobium*. Molecular docking was used to evaluate their binding affinity to key nodulation proteins (NodD and NodZ), while ADMET profiling assessed stability, safety, and bioactivity. Several metabolites showed strong binding energies and favorable interactions with nodulation proteins, indicating potential to enhance early plant bacteria signaling. Most compounds also displayed good absorption and low predicted toxicity. These findings highlight promising natural metabolites that may promote nod gene activation and strengthen nitrogen-fixing symbiosis, supporting future experimental and sustainable agricultural applications.

Keywords: *Lotus japonicus*, Bradyrhizobium, secondary metabolites, flavonoids, isoflavonoids, NodD, NodZ, molecular docking, ADMET profiling, nodulation, nitrogen fixation, plant–microbe interaction, sustainable agriculture.

Development of Plant-Based Alginate Beads as a Slow-Release Larvicidal System Against Mosquito Larvae

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Abstract

Mosquito-borne diseases remain a serious health threat, and most widely used larvicides either impose environmental hazards or develop resistance over time. Plant-based compounds are safer alternatives, but most research depends upon crude extracts that degrade rapidly in water and are not easy to store for a longer period of time. This study investigates the feasibility of using alginate beads as carriers for plant bioactive molecules to slowly release them and thus render them useful in field applications in mosquito control. Beads were prepared by a simple ionotropic gelation method using sodium alginate and calcium chloride. Blank beads were first prepared to normalize the shape, firmness, and stability of the beads in water. Subsequently, plant extractloaded beads were prepared by the same method and studied for integrity and release pattern over 24 hours. The extract-loaded beads released their contents slowly while maintaining their shapes, indicating that the formulation works as a slow-release system. These initial observations seem to indicate that alginate beads may provide an eco-friendly alternative to chemical larvicides with better stability. Further bioassays with mosquito larvae will help determine their actual effectiveness and possible use at the community level for mosquito control.

Keywords: Alginate beads, mosquito larvae, plant-based larvicide, slow release, eco-friendly vector control

Pollen Germination as a Bioindicator of Herbicide-Induced Ecotoxicity

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Abstract

Herbicides are common in modern agriculture, but they increasingly threaten the reproductive processes of non-target plants. However, pollen toxicity is rarely considered in regulatory risk assessments. This review looks at in vitro pollen germination and tube growth as quick and cost-effective bioindicators of herbicide-induced toxicity. The goals are to (i) summarize the effects of commonly used herbicides, (ii) identify dose-dependent and species-specific toxicity patterns, and (iii) evaluate the use of pollen assays for early-warning ecotoxicological screening. A literature-based approach combined peer-reviewed studies that report quantitative germination or tube growth responses after herbicide exposure. The findings show that glyphosate, 2,4-D, metolachlor, and pelargonic acid significantly reduce pollen viability and tube growth in a concentration-dependent way. They often cause metabolic disruption, ROS imbalance, and morphological issues like swelling or rupture. Species sensitivity differs; for instance, pelargonic acid is more toxic than glyphosate in hazel pollen, while glyphosate caused around 66% viability loss in *Rosa acicularis*. These similar responses emphasize pollen's high sensitivity to chemical stress and support its inclusion in environmental risk assessments to improve the detection of sub-lethal impacts from herbicides and encourage sustainable farming practices.

Keywords: Pollen germination; Herbicide toxicity; Pollen tube growth; Bioindicator

Horticultural Expansion and Its Ecological Impacts on Forest and Endemic Species in the Eastern Himalayas

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Abstract

The Eastern Himalayas host exceptional biodiversity, yet expanding agriculture and horticulture in Arunachal Pradesh have intensified ecological pressure. In the Siang basin, covering Upper and East Siang, forests and secondary vegetation are increasingly converted into orchards under schemes such as the Kiwi Mission 2025–35. This study examines how these transitions affected forest integrity and endemic-species habitats from 1985 to 2025. Multi-temporal Landsat and Sentinel imagery were analysed in QGIS and Google Earth Engine to generate NDVI and NDWI indices for assessing changes in vegetation greenness and surface-water conditions, supported by policy documents and published literature. The assessment shows reduced vegetation cover and water stability in valley and foothill zones where horticulture has intensified. Forest thinning and edge expansion near road corridors and terraces indicate rising fragmentation. Endemic species such as *Rhododendron arunachalense* and *Michelia punduana* now persist in interior forest patches bordering orchard areas. State records note horticulture expanding to nearly 165,000 hectares by 2023, reflecting strong policy momentum but growing ecological strain. Horticultural growth improves livelihoods but lowers biodiversity resilience and watershed stability. Integrated land-use planning with biodiversity zoning, agroforestry buffers, and watershed-based management is needed to maintain ecological balance in the region.

Keywords: Upper Siang, East Siang, horticultural expansion, endemic species, NDVI, Eastern Himalayas, forest fragmentation

Evaluating the Effect of Herbicide on Root Meristem in Plant

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Abstract

Root meristems are highly sensitive area due to their continuous and active cell division, making them effective indicator of chemical toxicity. Herbicides, mostly used for weed management, often interfere with the cellular process in non-target plant tissue. This review collect and analyze literature focused on the cytotoxic and genotoxic responses of root meristem cell- mainly in *Allium cepa* and *Vicia faba*, widely used cytogenetic model plants. Across multiple studies, herbicide treatment has been shown to slow down the cell division, causing chromosomal defect including stickiness, chromosome bridges and lagging chromosome etc. These disruptions collectively impair the meristem organization and root growth. Studies have shown that combination of herbicides can produce even more toxic effect compared to a single herbicide. Overall, the review highlights chromosomal aberration and altered mitotic index as reliable indicator of herbicide toxicity, emphasizing the broader environmental implications of herbicide use.

Keywords:

Herbicide toxicity, root meristem, mitotic index, chromosomal aberration, cytotoxicity, genotoxicity.

Hidden Reproductive Toxicity of Herbicides: herbicides do not just affect weeds- they silently weaken the next generation of plants

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Abstract

Herbicides are essential in modern agriculture, but their subtle effects on plant reproduction often go unnoticed. This review examines how commonly used herbicides influence key stages of pollen biology, including pollen viability, germination, tube elongation, and subsequent fertilization. Findings from multiple plant species reveal that even low herbicide doses can slow pollen germination, alter tube structure, disrupt cellular processes, and ultimately reduce fertilization success and seed formation. These impacts frequently occur before visible damage appears on leaves or stems, showing that herbicides can cause hidden reproductive stress. The review further highlights differences in species sensitivity and the importance of exposure timing. By focusing on these reproductive responses, this work emphasizes the need for better evaluation of herbicide safety to support sustainable crop production and protect plant biodiversity.

Keywords: Herbicides, Pollen Biology, Pollen Tube Growth, Fertilization, Reproductive Toxicity, Plant Physiology, Crop Sustainability

Iron Oxide Nanocomposites: A Promising Catalyst for Dye Degradation

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Abstract

Due to fast growing industrialisation in textiles and other fields, the use of synthetic dyes and organic pollutants have increased a lot. To treat the dye contaminated waste water (10-200 mg/L of dye) is the most challenging task because of its significant impact on the environment and the traditional methods available are not that efficient. This study focuses on finding a cost-effective alternative for this problem providing environmental and industrial benefits. In recent years, Iron oxide nanoparticles have gathered so much attention because of their exceptional physiochemical properties such as superparamagnetism, higher surface to volume ratio, surface area and feasible magnetic separation, which makes them applicable in various fields. This research work outlines the synthesis of iron oxide nanoparticles through co-precipitation, employing various capping agents at different concentrations and temperatures with NaOH as the base. The nanoparticles were further combined with carbon ash obtained from natural precursors (Musaparadisiaca, Saccharum officinarum, and Mangifera indica) to synthesize nanocomposites. The iron nanocomposites were characterized by UV-Visible spectroscopy, XRD and FTIR analysis giving absorbance in the 250-380 nm range and band gap energies between 2.15 eV and 3.92 eV using tauc's plot. The formed composites result in approximately 95% visual degradation (in 5 minutes) of toxic dyes methylene blue and eosine. Overall, this study shows iron nanocomposites as potential agents for efficient dye degradation, indicating their application for water purification.

Keywords: Coprecipitation, Nanocomposite, Superparamagnetism, Organic pollutants, Iron oxide nanoparticles

Inhibition of STAT3 in the JAK-STAT pathway of atopic dermatitis: molecular docking of Desrhamnosyl acteoside from Foxglove as a potential inhibitor

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Abstract

Atopic Dermatitis (AD) is a chronic inflammatory skin disorder characterized by intense itching, redness and inflammation in the skin. AD is primarily mediated through the JAK-STAT signaling pathway. Among the key transcription factors, Signal Transducer and Activator of Transcription 3 (STAT3) plays a crucial role in AD pathogenesis, including immune cell differentiation (Th1, Th2, Th17/Th22), skin barrier integrity, and the perception of itch. Current treatment for AD such as immunosuppressants and corticosteroids is associated with major side effects with prolonged use and this highlights the need for safer, plant-based alternatives. In this study, molecular docking was performed to evaluate the binding affinity of Desrhamnosyl Acteoside, a phenylethanoid glycoside derived from the herb Foxglove (Digitalis purpurae), against the STAT3 protein. The 3D structure of STAT3 (PDB ID: 6SMB) was retrieved from the RCSB Protein Data Bank, and molecular docking was carried out using Schrödinger's Maestro software to analyse ligand-receptor interactions. Desrhamnosyl Acteoside demonstrated a good docking score, indicating significant inhibitory potential against STAT3 protein. These findings suggest that Desrhamnosyl Acteoside could serve as a natural STAT3 inhibitor and a promising lead compound for developing novel drugs against AD.

Keywords: Atopic Dermatitis, Foxglove, JAK-STAT pathway, STAT3, Desrhamnosyl Acteoside

A Detailed Study on $NiCeFeO_4$ Trimetallic Nanoparticles: Synthesis, Characterization and Practical Relevance

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Abstract

Ni-Fe-Ce trimetallic oxide nanoparticles were synthesized via top- down (solid state method) and bottom- up (co-precipitation method, pechini method) approaches. The Ni-Fe-Ce ternary metal oxide nanoparticle offers exceptional efficiency, owing to iron's redox flexibility, nickel's enhanced electrical conductivity and cerium's oxygen-vacancy-driven oxidation activity. The prepared nanoparticles are extensively researched for their roles in hydrogen evolution reaction, fuel cells, and dye degradation due to their high surface area, enhanced electron transfer capabilities, and remarkable stability. The prepared nanoparticles were characterized by XRD, UV, FTIR, FESEM, BET, VSM techniques.

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Keywords: trimetal oxide, oxidation activity, nanoparticles, dye degradation, co-precipitation, pechini method

Click Chemistry 2.0: When Chemistry Clicks with Code

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Abstract

Click chemistry, as first articulated by Kolb, Finn, and Sharpless (2001), has revolutionized synthetic design and synthesis methodology through modularity, reliability, and efficiency under mild and sustainable conditions. In recent years, these same qualities like orthogonality, rule-based reactivity, and high predictability have made click reactions ideal models for computational exploration and potential advance's investigation. This poster presents the evolution of click chemistry with the accelerating capabilities of artificial intelligence (AI) and data-driven computation.

By mapping the algorithmic nature of click transformations into reaction databases, machine learning models can learn from consistent input–output relationships. These can thus forecast optimal conditions, design orthogonal ligation systems, and predict novel click-like transformations. AI-assisted retrosynthesis planners and neural network predictors, trained on click-based datasets, also have demonstrated increasing success in generating chemically valid and sustainable synthetic routes. Such computational frameworks not only enhance reproducibility but also support green chemistry goals by minimizing experimental redundancy, waste, and energy consumption.

This combination of chemistry and computation redefines the discovery process itself by going from intuition-led to data-informed exploration. As predictive models continue to evolve, the frontier of click chemistry expands toward autonomous laboratories capable of guided, modular synthesis supporting green chemistry vision. The study reflects how computational chemistry and AI can transform "click" from a methodology into a work where chemistry not only clicks in the flask but also computes in the cloud.

Keywords: Click chemistry, Artificial intelligence, Computational synthesis, Machine learning, Retrosynthesis, Green chemistry, Predictive modelling

Thermodynamic and Spectroscopic Investigation of Molecular Interactions in N-Methylacetamide(NMA) + Polyethylene Glycol (PEG 200/300/400) Binary Mixtures

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Abstract

The molecular interactions in N-methylacetamide (NMA) + polyethylene glycol (PEG) mixtures are studied from the measurements of the densities, ρ and speeds of sound, u of NMA + PEG 200, PEG 300 and PEG 400 mixtures across the entire range of composition at temperatures, T/K = (293.15–323.15) and pressure, p = 100 kPa. The excess parameters, viz., excess molar volume, excess isentropic compressibility, excess intermolecular free length and excess acoustic impedance were calculated from the measured data.These parameters have been interpreted in terms of molecular interactions in these systems. Also, the FT-IR spectra of pure NMA, PEG and near equimolar NMA + PEG mixture were recorded and examined to substantiate the nature and extent of prevailing inter- molecular interactions, speeds of sound, u of NMA + PEG 200, PEG 300 and PEG 400 mixtures across the entire range of composition at temperatures, T/K = (293.15–323.15) and pressure, p = 100 kPa.

Keywords: N-methylacetamide; polyethylene glycol; excess molar volume; isentropic compressibility; excess intermolecular free length; excess acoustic impedance FT-IR.

Synthesis, Characterization and Potential Application of Mn dioxide nanoparticles

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Abstract

Manganese dioxide nanoparticles were synthesized by the co-precipitation method using various capping agents, including L-glutamic acid, L-cysteine, sodium borohydride, Ascorbic acid, and sodium citrate as stabilizing agents. The concentration of these used capping agents significantly impacts the nanoparticles properties, such as size, shape, and surface chemistry. The synthesized nanoparticles were characterized using X-ray diffraction (XRD), which revealed a crystalline structure and confirmed the successful synthesis of nanoparticles. The optical properties were studied using UV-visible spectroscopy, which showed band gap energy between 2.82-4.59 eV. The synthesized nanoparticles demonstrated excellent photocatalytic activity with methylene blue and Eosin degradation within 15 and 20 minutes, respectively. The nanoparticles might have a high surface area, crystallinity, and an energy-band gap, contributing to their enhanced catalytic performance. These nanoparticles and their nanocomposites can be used in the treatment of textile dye industry wastewater, which leads towards environmental sustainability.

Keywords: Manganese dioxide nanoparticles, capping agents, X-ray diffraction (XRD), band gap energy between2.82-4.59eV, photocatalytic activity, treatment of textile dye industry wastewater.

Green Corrosion Inhibition Using Hibiscus Flower Extract for Mild Steel in Acidic Medium

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Abstract

Corrosion of mild steel is a significant challenge in industries such as construction and manufacturing, particularly when exposed to acidic environments during processes like acid pickling. While conventional synthetic inhibitors effectively mitigate this issue, their inherent toxicity, high cost, and non-biodegradability pose serious environmental and health risks. This study investigates the efficacy of *Hibiscus rosa-sinensis* (China rose) flower extract as a sustainable, eco-friendly "green" corrosion inhibitor for mild steel in a 1M hydrochloric acid (HCl) medium.

The aqueous extract was prepared from dried hibiscus petals and tested at varying concentrations (1%, 3%, and 5% v/v) using the gravimetric (weight loss) method at room temperature over a 4 hour immersion period. Experimental results demonstrated that the *Hibiscus* flower extract significantly retards the corrosion rate of mild steel. The inhibition efficiency was found to be concentration-dependent, increasing with the amount of extract added, and achieving a maximum efficiency of approximately 85–90% at a 5% concentration. Visual inspection of surface morphology confirmed that mild steel samples treated with the extract exhibited a smoother surface with significantly less rust compared to uninhibited samples.

The study attributes this protective effect to the presence of phytochemicals such as flavonoids, anthocyanins, and phenolic acids within the extract. These organic compounds adsorb onto the metal surface, donating electrons to the vacant d-orbitals of iron atoms to form a stable, protective film that blocks corrosive agents. In conclusion, *Hibiscus rosa-sinensis* extract serves as a highly effective, biodegradable, and cost-efficient alternative to hazardous synthetic inhibitors for industrial applications.

Keywords: Green corrosion inhibitor, *Hibiscus rosa-sinensis*, Mild steel, Adsorption, Weight loss method, Eco-friendly.

Catalysis for Climate Solutions Bridging Chemistry and Environmental Stewardship

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Abstract

Climate change and escalating environmental degradation have intensified the global demand for scientifically driven, scalable climate solutions. Catalysis—long established as the foundation of chemical transformation—has emerged as a transformative technology capable of addressing some of the most urgent environmental challenges. This study examines recent advances in organocatalysis, photocatalysis, and electrocatalysis (2020–2025), highlighting their potential to reshape modern industries through sustainable reaction pathways, reduced activation energies, and eco-friendly synthesis routes. Catalytic systems now enable metal-free organic transformations, low-temperature industrial processes, and the conversion of greenhouse gases into valuable fuels and chemicals, thereby contributing directly to reduced global emissions and circular carbon utilization. A significant emphasis is placed on catalytic CO_2 capture and conversion technologies, which facilitate the transformation of atmospheric CO_2 into methanol, formic acid, syngas, and other industrially relevant products. Furthermore, photocatalytic and electrocatalytic water splitting show promise in enabling large-scale green hydrogen production, a cornerstone of future clean-energy systems. These innovations collectively demonstrate how catalysis can support a shift toward low-carbon industries while maintaining economic feasibility.The societal relevance of catalytic science is particularly evident in regions experiencing severe air pollution, such as Delhi, where particulate matter ($PM_{2.5}$ and PM_{10}), nitrogen oxides, volatile organic compounds, and carbonaceous emissions consistently exceed safe limits. Advanced catalytic converters, selective catalytic reduction units, photocatalytic air-purifying surfaces, and catalyst-assisted biomass-to-energy systems offer practical pathways to reducing emissions from transport, industrial operations, and combustion sources—three of the primary contributors to Delhi's air-quality crisis. Moreover, next-generation catalysts capable of decomposing NO_x and VOCs in real time present promising avenues for urban air purification. By uniting fundamental chemistry with environmental responsibility, catalysis emerges as a cornerstone of climate action. Its integration into energy production, industrial reform, pollution control, and CO_2 valorization underscores its central role in creating a sustainable and resilient future. The findings emphasize that catalytic innovation is not merely a scientific advancement but a critical strategy for combating climate change and improving air quality in rapidly urbanizing environments like Delhi.

Keywords: Catalysis, Climate Change Mitigation, Organocatalysis, Photocatalysis, Electrocatalysis, CO_2 Conversion, Green Hydrogen, Air Pollution, Delhi Pollution, Sustainable Chemistry, Environmental Catalysis, Green Technology

Green Luminescent Nanomaterials: A sustainable route for Anti-counterfeiting Inks

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Abstract

Counterfeiting of currency, goods and commercial products continues to be a persistent global challenge that threatens economic security. There by intensifying the demands for advanced, cost-effective, sustainable, and security materials. The earlier used traditional security inks often rely on toxic metals or synthetic kind of dyes which are unstable and less fluorescent.

Recent progress in the eco-friendly synthesis strategies, including cost-eUective biomass-derived precursors, also solvent-free methods, and low-energy processes which reduce global and atmosphere impact while enhancing emission stability. The photophysical mechanisms behind the purpose is their strong green luminescence, including those defect-state emission, the surface passivation, and the ligand-induced quantum eUects. Fluorescent nanomaterials, such as carbon quantum dots, doped metal oxides, oUer unique optical properties that serves as invisible with verifiable security features, good for secure labeling and authentication of currency notes. This review briefs the key materials, mechanisms and the potential of Luminescent nanomaterials for scalable smart anti- counterfeiting technologies with the real world applications, highlighting how nanomaterials can serve as reliable tools against forgery.

Keywords: Counterfeiting, sustainable, Fluorescent, carbon quantum dots, labeling, Luminescent, nanomaterials

The Strategic Periodic Table: How rare earth elements shape Sustainability, Technology and Global Policy

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Abstract

Rare earth elements (REEs) — the 15 lanthanides plus scandium and yttrium — are critical enablers for modern technologies from electric vehicles and wind turbines to smartphones and defence systems. Their unique electronic configuration (4f orbitals) gives rise to magnetism, luminescence and catalytic behaviour, making them indispensable to high-performance applications. Yet while REEs are abundant geologically, economically viable mining, separation chemistry and global supply-chain control are highly concentrated. In 2024, global production of REO (rare earth oxides) reached ~ 390,000 t, of which China produced ~ 270,000 t (~ 69% of global output). The combination of high technological demand, chemical processing complexity and geopolitical concentration makes REEs a strategic material bridging chemistry, policy and sustainability. The global political economy of REEs is shaped by highly uneven extraction and especially processing capacities. Over the past two decades, policy measures, low-cost processing investments, and regulatory environments concentrated refining and value-addition in a small number of producing states, producing supply-chain chokepoints and episodic market shocks when export policies or trade frictions escalated. These dynamics have driven recent national strategies (stockpiles, alliance building, and domestic processing investments) and regulatory efforts to classify REEs as "critical minerals" central to economic security. The geopolitics of REEs therefore emerges from an interplay of geology, process chemistry, and trade policy — where laboratory-scale separations and refining steps have direct diplomatic consequences.

Art in the Uncanny Valley: An Analysis of Ethical Conflict in AI-Generated Media

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Abstract

Artificial Intelligence (AI) tools such as Midjourney and DALL·E have reshaped digital art creation by enabling seamless synthesis of human imagination and algorithmic computation. However, this rapid expansion of AI-generated media has intensified debates around authenticity, artistic integrity, and copyright ethics. A major source of conflict arises from "style scraping," where prompts mimic copyrighted or culturally distinct visual styles such as Ghibli-style or Anime-style. This study investigates the prevalence and patterns of ethical concerns surrounding AI-generated artwork, using a dataset of 500 images and social-media metadata from trending "Ghibli-style" posts. After preprocessing and TF-IDF prompt analysis, correlation and pattern-detection techniques were applied to identify which prompts, platforms, and content types most frequently trigger ethical dilemmas. Results show that 48.2% of AI-generated posts were flagged for ethical concerns, with style-specific prompts showing the strongest correlation to accusations of plagiarism and misuse of artistic labour. Instagram emerged as the most conflict-intensive platform, reflecting active public discourse around ownership and artistic originality. These findings highlight the growing tension between AI creativity and ethical boundaries in digital art spaces, underscoring the need for clearer frameworks on authorship, artistic rights, and responsible AI-art practices.

Keywords: AI-generated art, ethical conflict, style scraping, Ghibli-style prompts, digital originality, plagiarism.

Comparison between Different Machine Learning Algorithms for Diabetes Prediction

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Abstract

Diabetes or diabetes mellitus is an incurable metabolic disease that is characterized by abnormal rises in blood sugar levels(hyperglycemia) due to insufficient insulin production in the body or the body's inability to use insulin effectively. It is a global health concern; The recent report of the International Diabetes Federation (IDF) Diabetes Atlas (2025) says that 11.1% (589 million) of the adult population has diabetes. And by 2050, 1 out of every 8 adults, i.e., approximately 853 million adults, will suffer from diabetes, which shows an increase of 46% from current numbers.

Given that it is an incurable disease, both its early prediction and identification are necessary. This research focuses on the prediction of diabetes using the Pima Indian Diabetes dataset. This paper aims to compare the performance of different machine learning algorithms, including Random Forest, XGBoost, Support Vector Machine (SVM), K-Nearest Neighbors (KNN), and Naïve Bayes (NB), on the Pima Indians Diabetes Dataset, to observe which algorithm works the best to predict diabetes. The algorithms are compared and evaluated on the basis of various evaluation metrics, including accuracy, precision, recall, F1-score, and confusion matrix, which are used to assess the models' predictive power. The results of this study provided insights into the best-performing model for diabetes. It was observed that among all the models, XGBoost and SVM achieved the highest accuracy, followed closely by Random Forest and KNN. Considering overall balance across all metrics and AUC, XGBoost stood out, with a high F1-score, recall, and AUC, indicating better handling of class imbalance.

Keywords: Diabetes, Machine Learning, Pima Indian Diabetes Dataset, Feature Selection, Predictive Modeling.

Computational Prediction of Phytochemicals Binding Using Machine Learning and Deep Learning Methods

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Abstract

Accurately predicting phytochemical–protein binding affinity is essential for advancing plant-based drug discovery, yet major challenges persist due to limited experimental datasets and the inherently complex nature of molecular interactions. To address these limitations, this study employs a hybrid AI-based framework that integrates molecular fingerprints, physicochemical descriptors, and protein-sequence features to model phytochemical–target binding. A combination of machine learning algorithms and deep learning techniques, including Graph Neural Networks (GNNs), was used to evaluate binding interactions. The predictive models achieved high performance with an AUC of 0.94 and an R^2 value of 0.78, further validated through Leave-One-Protein-Out cross-validation to ensure robustness across unseen protein targets. Model interpretability using SHAP analysis identified critical contributors such as Topological Polar Surface Area (TPSA), LogP, and GRAVY index as key determinants of binding affinity. The computational results were further supported by protein pocket visualization, confirming complementary ligand–receptor interactions. These findings highlight the potential of the proposed AI-driven pipeline as a reliable and interpretable tool for large-scale phytochemical screening and early-stage drug discovery.

Keywords: Phytochemicals, Binding Affinity, Machine Learning, Graph Neural Networks, SHAP Analysis, Protein–Ligand Interaction.

Dynamic Relationship Between Bitcoin and Gold in INR : Evidence from Rolling Correlation and Portfolio Analysis

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Abstract

Bitcoin and Gold are two assets increasingly compared for their roles in portfolio diversification and crisis protection. For Indian investors, however, their behavior can differ substantially once prices are evaluated in INR terms, making it important to understand how global shocks and currency movements shape their relationship. This study investigates the dynamic linkage between Bitcoin and Gold from 2016–2025 using daily USD prices converted to INR through date-wise USD/INR exchange rates. Rolling correlation analysis, volatility measures, tail-risk estimation (95% VaR and CVaR), and event-wise segmentation were performed to capture time-varying co-movement across four global regimes: Pre-COVID, COVID-19, War–Inflation, and Recovery.

The results show that Bitcoin–Gold correlation is not stable and shifts markedly with macroeconomic conditions. Correlation peaks during the COVID period, while weakening in recovery phases, indicating alternating phases of diversification and co-movement. Volatility comparison reveals that Bitcoin is substantially riskier in INR terms, with annualized volatility ranging from 22% to 138%, compared to Gold's 9% to 38%. Tail-risk metrics further highlight deeper downside exposure for Bitcoin. Portfolio simulations demonstrate that moderate Bitcoin exposure (20–30% allocation) yields the highest Sharpe ratio, suggesting that Bitcoin adds value only when used in controlled proportions alongside Gold.

These findings provide INR-specific evidence that Gold continues to act as the more stable risk-hedge for Indian investors, while Bitcoin enhances returns when markets stabilize. The study contributes a currency-adjusted perspective on Bitcoin–Gold dynamics and offers practical insights for constructing balanced portfolios under varying global macroeconomic conditions.

Keywords: Bitcoin, Gold, INR returns, Rolling correlation, Risk analysis, Portfolio diversification.

Enhancing Heart Disease Prediction Using Chi-Square Feature Selection and SMOTE-ENN Balancing: A Comparative Study of Machine Learning and Deep Learning Models

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Abstract

Heart disease remains one of the leading causes of morbidity and mortality worldwide, emphasizing the need for reliable and interpretable predictive tools in clinical decision-making. In this study, the Cleveland Heart Disease dataset was utilized to investigate whether simple machine learning models, when paired with robust preprocessing techniques, can perform comparably to more complex deep learning architectures. Feature selection was conducted using the Chi-Square test, and class imbalance was addressed through the SMOTE-ENN hybrid resampling technique. Subsequently, models including Logistic Regression, Decision Tree, Random Forest, and a Deep Learning network were trained and evaluated under multiple preprocessing configurations to analyze their predictive capabilities. The results demonstrate that well-designed and transparent machine learning models can achieve predictive performance on par with deep learning methods, while offering superior interpretability and ease of deployment in healthcare environments. These findings highlight the potential of simpler, explainable models as practical and efficient tools for heart disease prediction.

Keywords: Heart Disease Prediction, Chi-Square Feature Selection, SMOTE-ENN, Machine Learning, Deep Learning, Model Interpretability.

From Well-being to Wellness:analyzing happiness index and life expectancy of india vs globally

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Abstract

This study investigates the relationship between the Happiness Index and Life Expectancy in India. It compares these trends with global patterns from 2005 to 2024. Special attention is given to the impact of COVID-19. While many associate happiness with wealth or comfort, the Happiness Index emphasizes deeper factors. These include social trust, mental well-being, and a sense of purpose. India consistently ranks lower than the top five countries. This highlights that economic growth alone does not guarantee overall well-being. Data from the World Happiness Report is used. It includes 2,199 observations across 13 key variables. Random Forest Regressor and feature selection techniques are applied. These identify the factors most strongly influencing happiness and life expectancy. The analysis reveals that GDP per capita and life expectancy are the most significant predictors of happiness. Social support also has a strong effect. Generosity and perceptions of corruption have minimal impact. Conversely, happiness emerges as the strongest predictor of life expectancy. Economic stability and social support further support this relationship. The study finds that COVID-19 caused a sharp decline in India's happiness. Recovery has remained slow compared to global leaders. These findings highlight the importance of psychosocial factors. They are critical alongside economic development in enhancing well-being. The results can inform policy strategies aimed at improving life quality in India.

A study of m-Kannan contraction

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Abstract

Fixed point theory plays a central role in nonlinear analysis and applied mathematics. The Banach contraction principle guarantees a unique fixed point for contractive mappings on complete metric spaces, and its generalization by Kannan (1968) removed the requirement of continuity. However, it remains unclear whether similar results hold when iterates of a mapping satisfy Kannan-type conditions. This study addresses this theoretical gap by examining generalized contractions under relaxed assumptions. The main goal of this work is to study and analyse *m*-Kannan contractions. Our work will focus on finding conditions under which these map- pings possess unique fixed point. In our research work, we use analytical methods based on complete metric space and iterative sequences are analysed to show convergence under *m*-Kannan conditions, and we provide examples to confirm that results for both continuous and discontinuous cases. The proposed *m*-Kannan contraction generalizes the classical Kannan contraction ($m = 1$). Under *k*-continuity, the mapping admits a unique fixed point, with convergence from any initial point. Without continuity, the iterative sequence converges to a unique limit, which may not be a fixed point. We provide an example to show that the *m*-Kannan class is strictly larger than the Kannan class and includes discontinuous mappings. This study extends Kannan's fixed point theorem by developing the *m*-Kannan framework, demonstrating that continuity is a sufficient but not necessary condition for the existence of fixed points. The results broaden the understanding of contraction-type mappings and open new avenues for exploring non-continuous operators within fixed point theory.

Keywords: Kannan contraction, Banach contraction, iterates, k-continuity, m-Kannan contraction.

Numerical Solution of one-dimensional Burger's Equation using Hopf -Cole Transformation and Crank-Nicolson scheme

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Abstract

Various phenomena that exist in the real life such as modeling traffic flow, analysing gas dynamics and shock waves, cancer modeling, cosmology, etc. can be represented or studied using Burger's Equation. Understanding Burger's Equation can help us bridge the gap that exist between mathematical and physical significance. Burger's Equation is a fundamental non-linear partial differential equation that models the balance between non-linear convection and diffusion term. The objective of the research is to obtain the numerical solution of the solve the one space dimensional Burger's Equation. We first solved the Burgers equation using Hopf Cole Transformation which transforms the non-linear Burger's Equation into linear heat equation. The transformed heat equation is solved using Crank Nicolson Discretization scheme, yielding a system of algebraic equations. Further the Burgers equation is solved using Crank-Nicolson scheme without Hopf Cole transformation. The numerical results from both are compared with analytical solution for different values of viscosity. The efficiency analysis is done based on the asymptotic analysis and running time of the program with different grid sizes.

Keywords: Burger's Equation, Hopf Cole Transformation, Crank Nicolson, Absolute Error.

Solving Multiobjective Optimization Problem via Scalarization

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Abstract

Studying multiobjective optimization problems is very important as many real world problems involve objectives which are conflicting in nature. So, we need to create a balance between various conflicting objectives to arrive at the best or optimal solution in some appropriate sense because if there exists a solution that optimizes all the objectives simultaneously then we would have obtained an ideal solution. But quite often, it happens that improvement of one objective results in a loss of another leading to an unlikely existence of an ideal solution. The objective of this study is to solve the multiobjective optimization problem. In this research work, we will be solving a given multiobjective optimization problem by converting it into a single-objective problem i.e. A scalar problem which is much easier to solve as compared to a given complex problem. That's why we call it solving a multiobjective problem via a scalarization approach. For a single real valued function, it is easy to find out an optimal value as real values are easily comparable. In contrast to this, the space R^n, $n \geq 2$, for example, is not an ordered space unless we define an appropriate partial order for comparing its elements.

Keywords: Optimization, Multiobjective Programming, Scalarization

On some irreducibility criteria of a polynomial having integer coefficients

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Abstract

The problem of finding an irreducibility of a polynomial with integer coefficient fascinated several mathematicians. Some well-known classical irreducibility criteria are Eisenstein's irreducibility criterion, Mod p (p is prime) irreducibility criterion and reducibility test for 2- and 3-degree polynomials etc. Proceeding in the same direction, we study an irreducibility criterion of a polynomial f(x) with integer coefficients via prime p. More precisely, if we express p in base 10 as $p = a_m 10^m + a_{m-1}10^{m-1} + ... + a_1 10 + a_0$, then the polynomial $f(x) = a_m x^m + a_{m-1}x^{m-1} + ... + a_1 x + a_0$ is irreducible in $Z[x]$. Now for a fix b(t) in $F_q[t]$, where F_q is a finite field and q is a prime power, the above result can be generalized, if for a given irreducible polynomial p(t) in $F_q[t]$. we write $p(t) = a_m(t)b(t)^m + ... + a_1(t)b(t) + a_0(t)$, then the polynomial $f(x) = a_m(t)x^m + ... + a_1(t)x + a_0(t)$ is irreducible in $F_q[t, x]$.

Keywords: Polynomial, Irreducibility, Field.

Decoding E-Shopping Choices: Statistical Insights on Sales Sensitivity and Subscription Trends

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Abstract

This research analyses the way in which seasonal sales strategies and subscription-based models influence the digital buying habits of young Indian consumers. In regard to this, a questionnaire was circulated, and data were collected from people aged 18-24 in June 2024 in order to get valuable insights into the role of promotional sales strategies on consumer decision-making. The reliability analysis of the study confirms the strength of the data, which reveals that online shopping is the preferred mode of purchase among participants, with a majority of them reporting that they will postpone purchases until the sales period and subscribe to at least one digital service. The correlation analysis highlights some important key trends: Consumers who favour discounts don't generally show platform loyalty; transparent practices encourage peer review; and loyalty incentives, though present, have only a moderate impact, and that too in the fashion sector only. Although saving money is a motivator, it is not the only one leading to the switching of services. Other non-monetary factors, such as trust, ease of use, and personalization, also have a big role in shaping consumer preferences. Businesses can therefore strengthen their long-term relationships with young consumers by adopting transparent policies and timely execution of seasonal campaigns.

Keywords: Consumer Behaviour, Online Shopping, Seasonal Trends, Subscription-based Models, Correlation Analysis

Approximation by integral form of the operators involving Miller-Lee polynomials

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Abstract

In the year 2021, Sucu introduced a sequence of Stancu type operators including generalized Brenke polynomials. He studied some approximation properties of the operators. There are several integral modifications of well-known operators like Bernstein, Baskakov and Szász operators that are developed and studied. In the present article, we introduce the two integral modifications of the operators given by Sucu based on Baskakov basis function and Szász basis function. First, we estimate moments of these operators and establish some approximation properties for our integral type operators in terms of first and second modulus of continuity and asymptotic formulae for these operators. We extend the class of functions from continuous to integrable and we employ the software 'Mathematica' in order to carry out various computations involved.

Keywords: Baskakov basis function, Szász basis function, Modulus of continuity, asymptotic formulae.

Sensitivity analysis in optimization

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Abstract

In practice, most of the parameters involved in optimization models are rarely fixed. Sometimes the cost fluctuates, sometimes the availability of resources changes, and sometimes the external conditions, like market demand, change. Re-solving an optimization problem from scratch each time these parameters change is impractical. Therefore, sensitivity analysis helps to determine how much variation an optimal solution can tolerate, making optimization more practical and reliable. The study will dwell on developing the understanding of sensitivity analysis in both LPP and NLP settings and how it aids in making better decisions. The goal of this dissertation is to analyze how changes in model parameters affect optimal solutions. Precisely, the research investigates sensitivity analysis in Linear Programming through the variation of cost coefficients and resource availability, after which an extension is made to Nonlinear Programming via Quadratic Programming Problems (QPP). We solve a Linear Programming Problem by the Simplex Method and then perform sensitivity analysis by varying systematically: i) cost coefficients (c_j) and ii) resource availability values (b), interpreting the changes that result in the optimum value, shadow prices, and feasible region. An example is used for the purpose of illustrating these changes.

Next, the Quadratic Programming Problem is considered and solved graphically by contour plots and representation of the feasible region. Then, sensitivity is applied by changing parameters in the quadratic objective function to see how the optimal point shifts. For the linear case, the results indicate that the optimal solution remains stable within certain ranges of allowable changes in cost coefficients and resource levels, beyond which the basis changes and production decisions adjust accordingly. The quadratic model is different, with parameter variations affecting the objective function and resulting in more complicated shifts in the position of the optimum. Graphical analysis can dramatically demonstrate how nonlinear models differ in the way that they respond to changes in parameters. The work emphasizes the practical relevance of sensitivity analysis as a means to investigate the robustness of optimization models. Both LPP and QPP analyses have shown how variation in parameters affects decision-making and allows decision-makers to make necessary changes in strategies without completely resolving the model. Generally, sensitivity analysis provides greater flexibility and credibility to the application of optimization in real-life uncertain scenarios.

Keywords: Optimization, Sensitivity Analysis, Linear Programming, Nonlinear Programming, Quadratic Programming Problems.

TOPSIS analysis for prioritising online learning platforms

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Abstract

With the rapid expansion of online learning platforms, it has become increasingly challenging for students to choose the best platform that aligns with their educational needs. This paper aims to prioritise the online learning platforms as per student needs and requirements. The study uses four key criteria, namely, ease of use, variety of courses, cost, and reputation of instructors. The MCDM technique, the TOPSIS method, is used to rank various alternatives based on their distance from the ideal best or ideal worst solution. The findings highlight the objectivity and transparency of the MCDA-TOPSIS approach in comparing alternatives and provide valuable insights into the relative strengths and weaknesses of each platform. This study assists students in making informed decisions and choosing a platform suitable for their study needs.

Keywords: Multicriteria decision making, Online learning platform, TOPSIS method, student needs, Criteria weights.

Learning With Errors (LWE)

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Abstract

The Learning With Errors (LWE) problem is one of the central hardness assumptions in modern cryptography. Introduced by Oded Regev in 2005, it has since become a cornerstone for constructing cryptographic primitives that are believed to be secure even against quantum computers. The LWE problem generalizes the classical Learning Parity with Noise (LPN) problem and captures the difficulty of solving systems of noisy linear equations over finite fields. To summarize the fundamentals of LWE and its role in developing secure, quantum-resistant cryptographic systems. The study reviews LWE's mathematical structure, noise model, hardness reductions to lattice problems, and its use in key cryptographic schemes such as encryption and signatures.

Keywords: Learning With Errors (LWE), lattice-based cryptography, post-quantum cryptography, hardness assumptions, cryptographic primitives, noise distribution, lattice problems, quantum-resistant security.

A Study on Screen Time Usage of Adolescents

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Abstract

In today's world, where education and everyday life are increasingly digital, screen time has become a normal part of adolescents' routines. While being constantly connected offers many benefits, it also raises important questions about the impact on young people's physical health, mental wellbeing, sleep, and social interactions. Despite these concerns, there is still a lack of detailed research in the Indian context that looks at how screen time relates to various personal, behavioral, and health factors all at once, especially for adolescents navigating life in a rapidly digitalizing society. The study aims to explore how the amount of daily screen time relates to various factors such as adolescents' demographic background, their patterns of device and internet use, lifestyle habits, and selected aspects of physical and mental health. The study uses a structured Google Forms survey shared with adolescents to collect information on demographics, parents' education, device types, internet access, phone usage habits, favorite apps, and Wi-Fi quality. It also asks about stress and anxiety related to screen time, eye strain, muscle pain, break habits, multitasking, screen-time controls, effects on concentration, sleep duration, physical activity, and BMI. The gathered data will be analyzed using descriptive and inferential statistics to explore links between screen time and these factors.

Keywords: Adolescents, Screen time, Mental health, Lifestyle behaviours, Digital habits.

Optimized Workforce Scheduling via Integer Linear Programming

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Abstract

Service industries, particularly call centers, face a critical challenge in minimizing operational costs while guaranteeing service level consistency against dynamically fluctuating demand. This research addresses the scheduling problem in managing a multi-skilled workforce: the necessity of trading off the lower cost of single-skill specialist agents against the greater operational flexibility and coverage provided by higher-cost multi (cross)-trained agents. The study aims to develop an integer linear programming model and apply a deterministic optimization framework to find the optimal assignment of three agent types, across two 8-hour shifts to minimize the total daily labour cost. This must be achieved while rigidly satisfying four non-negotiable minimum staffing demands for two skills during two distinct, overlapping time periods. We are using an Integer Linear Programming (ILP) model, a standard technique in Operations Research. The formulation includes six integer decision variables $x_{j,k}$ representing the count of each agent type on each of the two available 8-hour shifts. The objective function minimizes cost, factoring in the wage difference (₹160 vs. ₹200 per shift). The model is constrained by four linear inequalities, ensuring sufficient skilled coverage for the required staff levels. The model is designed to be solved computationally using the Branch and Bound algorithm. The optimal solution yielded a strategic hybrid staffing mix that utilized a necessary quantity of cross-trained agents in the overlapping shift period. This optimized approach resulted in cost saving and reduction in overstaffing. The optimal solution yielded a strategic hybrid staffing mix that utilized a necessary quantity of cross-trained agent.

Keywords: Branch and Bound, Cost Optimization, Integer Linear Programming, Optimization, Shift Scheduling Problem.

Phenomenological Modelling of Deuteron – A Lennard-Jones Potential Approach

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Abstract

Understanding nucleon-nucleon interactions at low energies has long been an active area of research in nuclear physics. While nucleons are composed of quarks at a more fundamental level, the calculational complexity associated with treating quark-quark interactions at low energies necessitates using alternative approaches for probing nuclear interactions. One of the most popular strategies towards studying nuclear systems is to adopt or construct phenomenological potential models, an approach which has proved to be considerably successful over the years in various contexts.

In this work, we consider the simplest of all nuclear systems, the Deuteron, a unique, loosely-bound system with just one proton and one neutron, which makes a wonderful test case to understand nucleon-nucleon interactions through phenomenological modelling. Furthermore, the knowledge of the Deuteron wavefunction is useful for an assessment of its polarization characteristics, as well as the determination of scattering amplitudes/transition amplitudes in nuclear reactions involving a Deuteron. Thus, such problems have previously been explored through various phenomenological models for nucleon-nucleon interaction in the literature, such as a Radial Potential Well, Woods-Saxon Potential, Reid Potentials, Argonne Potential, Morse Potential, and H ¨ulth´en Potential. In the present work, we develop a new phenomenological model with as few free parameters as possible, to describe the proton-nucleon interaction in a Deuteron. The key idea underlying this work is the common knowledge that the short range nuclear forces are attractive for some distance, but also have a repulsive core for inter-nucleon separation smaller than a certain optimal distance. This behavior is in-principle similar to the behavior of inter-molecular forces. Motivated by this similarity, we mathematically model this behavior by attempting a phenomenological potential from the Lennard-Jones family of potentials, which is commonly used in molecular dynamics, with $V(r) = \frac{A}{r^m} - \frac{B}{r^n}$ with m > n.

Besides the commonly used "12-6" variant of the Lennard-Jones Potential, we also adopt other phenomenological models from this family, especially the "8-2" Lennard-Jones Potential, which is also found to work reasonably well. We solve the Schr ¨odinger equation for the Deuteron with the said potentials, numerically using the finite-difference method. Key physical properties of the Deuteron, such as its Binding Energy, are extracted directly, while other attributes like the most probable radius (r_{mp}) , which may be taken as an estimate of the size of the Deuteron, and its root mean square radius (r_{rms}), are calculated with the aid of the computed Deuteron wavefunction, and verified against the experimentally known values for the

same, as well as against model-dependent calculations for the same within various other phenomenological models mentioned before. The results are resoundingly positive, as we find that our "8-2" Lennard-Jones Potential successfully generates the experimentally known Deuteron Binding Energy of 2.22 MeV, and gives a size estimate (through r_{mp}) as 1.96 fm, which is within 0.15% of the known size. This excellent agreement establishes that our model is firmly well-placed within the family of phenomenological models for the Deuteron.This work shows that nuclear interactions in this simple two-body system can be approximated using the Lennard–Jones family of potentials, and illustrates how the knowledge of the nature of nuclear forces can help us build an intuitive two/three-parameter pheonomenological model, which approximately reproduces the Deuteron attributes known experimentally from scattering studies, as well as from more evolved low-energy nuclear phenomenological models.

A Peek into Early Universe: GRB Calibration with Artificial Neural Network (ANN) on Hubble and Pantheon+ Data

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Abstract

Understanding the late-time expansion history of the Universe is a cornerstone of modern cosmology. The Hubble parameter, *H(z)*, encapsulates the rate of cosmic expansion as a function of redshift, serving as a direct probe of dark energy dynamics and deviations from the ΛCDM model. However, most determinations of *H(z)* rely on parametric assumptions such as specific forms of the dark energy equation of state that may bias the inferred expansion history. To avoid this, non-parametric reconstruction techniques have become increasingly important. This study presents a comparative reconstruction of the Hubble parameter using Gaussian Process (GP) regression and Artificial Neural Networks (ANNs), focusing on the ability of each method to capture ne-scale structure and uncertainty in the observational data.

The objective of this work is twofold: first, to evaluate how well GPs and ANNs can reconstruct *H(z)* from sparse and noisy observational datasets without imposing a cosmological model; and second, to quantify the robustness and interpretability of these reconstructions in the presence of observational uncertainties. Specifically, we seek to assess whether machine-learning-based approaches such as ANNs can complement or outperform kernel-based GP regression in capturing non-linear trends in *H(z)*.

The methodology involves reconstructing *H(z)* from a compilation of current observational data, including cosmic chronometers (differential age method) and baryon acoustic oscillation (BAO) measurements, spanning $0 < z < 2$. For the Gaussian Process reconstruction, we employ a squared-exponential kernel with hyperparameters optimized through maximization of the marginal likelihood. The GP inherently provides smooth functional interpolation with uncertainty estimates that depend on data density and noise level. In contrast, the ANN reconstruction is implemented using a fully connected feed-forward network with multiple hidden layers and non- linear activations (ELU and ReLU). The network is trained via backpropagation using mean squared error loss and regularized using dropout and early stopping to prevent overfitting. Bootstrap re-sampling is employed to estimate uncertainty bands around the ANN predictions, allowing a direct comparison with GP condence intervals.

The results show that both GP and ANN reconstructions reproduce the expected monotonic increase of *H(z)* with redshift and are broadly consistent with ΛCDM predictions within 1σ confidence regions. The GP provides smooth, conservative estimates with well-behaved uncertainties, but tends to underfit regions with rapid changes due to its kernel rigidity. The ANN, on the other hand, captures subtle non-linear features in the data, potentially indicating local deviations in the reconstructed expansion rate. However, its uncertainty quantication derived from bootstrapping rather than intrinsic Bayesian variance - is broader and less

structured. Quantitatively, both methods yield present-day Hubble constants H0 consistent with current observational bounds, with ANNs slightly favoring higher H_0 values than GPs.

In conclusion, Gaussian Processes remain the most statistically transparent and stable approach for non-parametric cosmological reconstructions, particularly when uncertainty estimation is critical. Nevertheless, Artificial Neural Networks demonstrate strong potential for detecting non-trivial patterns in sparse cosmological data when properly regularized and ensemble-averaged. A hybrid framework combining the interpretability of GP priors with the expressive power of neural networks may represent the next step toward robust, model-independent inference of the cosmic expansion history.

Sol-Gel Derived MoS_2 Thin Films for Sensitive Bilirubin Biosensing

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Abstract

Bilirubin is an important biomarker used to evaluate liver function. The abnormal levels often indicate liver disorders such as jaundice, hepatitis, and other metabolic complications. Early and accurate detection of bilirubin is essential for timely medical intervention, which can significantly improve treatment outcomes and reduce the risk of severe health complications. Electrochemical biosensors offer a promising solution due to their high sensitivity, low cost, ease of fabrication, and potential for real-time, point-of-care monitoring. In this work, MoS_2 thin films were synthesized using a simple and cost-effective sol-gel method, followed by deposition on Pt/Si substrates through spin coating under optimized processing conditions. The films were further treated with thermal annealing to enhance their structural and electrical properties. Characterization techniques such as X-ray diffraction (XRD), Fourier-transform infrared spectroscopy (FTIR), and UV-Visible spectroscopy confirmed the successful formation of crystalline MoS_2 with strong Mo–S bonding and an optical band gap of 1.2 eV. The electrochemical behaviour of the films was investigated for bilirubin detection using cyclic voltammetry (CV) and differential pulse voltammetry (DPV). The results showed that the films exhibit excellent sensitivity and selectivity toward bilirubin, highlighting their potential for accurate and efficient biosensing applications. Overall, this study demonstrates that sol-gel derived MoS_2 thin films provide a stable, reproducible, and cost-effective platform for bilirubin biosensors. These findings contribute to the development of compact and real-time diagnostic devices that can be used in healthcare for early disease detection and improved patient care.

Keywords: MoS_2 thin films; Biosensor; Bilirubin detection.

Photometric and Kinematic Study of Open Cluster using Gaussian Mixture Model (Melotte 111)

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Abstract

Open Clusters are often regarded as a laboratory for stellar evolution; stars in these clusters have similar ages and metallicities as they are formed through the same molecular cloud; the only major difference between them is their stellar mass. The simplest way to find an Open Cluster is by looking for star overdensities in the night sky, supplemented with a color–magnitude diagram. This study focuses on Melotte 111 (Coma Berenices), aiming to determine accurate membership probabilities, analyze cluster kinematics, and constrain its age and metallicity using Gaia DR3 photometric and astrometric data. Melotte 111 is a prominent celestial gathering located within the constellation Coma Berenices, renowned for its proximity to our Sun, at a distance of approximately 87 parsecs, located at approximately RA = 12h 23m, Dec = $+26^{\circ}$. We used photometric data from Gaia DR3 to determine the membership of the Cluster. A variety of machine learning models can be used; we applied the Gaussian Mixture Model (GMM) using parallax, proper motion in RA (pmRA), and proper motion in DEC as discriminating parameters. Reddening and extinction corrections were performed for the photometric dataset, followed by isochrone fitting to derive cluster physical parameters. We have applied this model to 8 other Open Clusters (OCs), with varying ages (log age 7.555 to 8.91) and distances (275.5 pc to 7004 pc), and compared our results for these clusters for different methods, and investigated the efficiency of this model for identifying the member stars in the cluster. For Melotte 111 we obtained pmRA = −11.0275 mas/yr and pmDEC = −8.36989 mas/yr, log age = 8.87506 and Metallicity $Z \approx 0.02$. Similarly, we have obtained the result for other clusters as well. However, the model showed reduced efficiency for distant clusters or those with low stellar density due to weaker dynamical contrast with surrounding field stars. The refined parameters will aid in understanding the early dynamical evolution of nearby clusters and calibrating stellar models. These results contribute to broader efforts in mapping the local Galactic environment and can be extended to other young clusters.

Enhanced Conductivity and Flexibility in Polyaniline-Based Thermoelectric Energy Harvesters: A Comprehensive Study

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Abstract

Organic polymer-based thermoelectric energy harvesters have garnered significant attention from both scientists and industry as a means to address the growing demand for renewable energy in the current era of climate change in a cost-effective way. In this context, the present study explores a range of PAni based composites and compares their performance with the goal of achieving a higher Seebeck coefficient, higher electrical conductivity and lower thermal conductivity. More than 15 PAni-based composite formulations were investigated, including varying concentrations of PEDOT:PSS (20, 30, 50%), conductive fillers (MWCNTs), different substrates (glass, pellet, PVDF), and compatibility with different solvents (DMSO, DMF), to determine the most suitable composition for flexible thermoelectric energy harvesters. Consequently, a thin and flexible thermoelectric film was developed via in-situ polymerization of polyaniline (PAni) combined with multi-walled carbon nanotubes (MWCNTs) in a PVDF matrix. The film demonstrated a stable voltage output and a distinct Seebeck coefficient of 556μV/K (PAni/PVDF) under a moderate temperature gradient when tested using a custom thermoelectric setup. Its excellent mechanical strength, lightweight nature, and reliable thermoelectric performance highlight its promise for application in wearable, flexible, and self-powered energy-harvesting devices.

Development of Low - Cost Biofilter for Laundry Wastewater for Safe Reuse

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Abstract

Rapid urbanization and growing population in India have increased the water scarcity. About 72% of sewage that is being left untreated contributes to surface and groundwater pollution. Laundry wastewater (LWW), contributes 21% of total domestic greywater and contains high levels of detergents, surfactants and organic pollutants, whose direct discharge is environmentally harmful. Centralized treatment systems are efficient but they are often energy intensive, expensive, and unsuitable for decentralized applications. The purpose of this study is to develop a low cost, household – level biofilter using locally available materials – gravel, sand and neem seed shells for treatment and reuse of LWW which aligns with SDG 6.3 (Improve water quality, wastewater treatment and safe reuse). Neem seed shell is an efficient adsorbent and it is a waste product in neem oil industry, sand and gravel enabling physical filtration and biofilm forms on them which helps in breakdown of organic matter present in greywater. Key parameters to be analysed are pH, temperature, chemical oxygen demand (COD), biological oxygen demand (BOD) etc. Based on previous findings and literature, it suggests that proposed system can reduce up to 70% COD and BOD with 70-80% surfactant adsorption, resulting in treated effluent suitable for non -potable uses like floor cleaning, cleaning stairs and corridors. The system is eco- friendly, affordable and easy to maintain, offering a suitable alternative for decentralized greywater management. This biofilter will potentially help achieve SDG 6.3 by treating LWW so it can be safely reused.

Keywords: SDG, Laundry wastewater, Greywater, Biofilter, Neem seed shell, Adsorbent

ARID4B: A Multifunctional Chromatin Regulator of Cancer and Reproduction

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Abstract

ARID4B (AT-Rich Interactive Domain-containing protein 4B) is a chromatin-associated transcriptional regulator belonging to the ARID protein family. Structurally, ARID4B contains an ARID DNA-binding domain, chromosomal domains, and coiled-coil motifs that mediate protein–protein interactions. It also possesses a unique interdigitated double Tudor domain (HTD) that binds directly to DNA through charge-based interactions, explaining its role in chromatin remodeling and gene regulation. These structural regions enable ARID4B to recognize specific DNA sequences and histone modifications, allowing it to regulate chromatin organization and transcriptional activity as part of the mSIN3A–HDAC1/2 corepressor complex.

Functionally, ARID4B has crucial regulatory roles in stem cell differentiation, epigenetic regulation, gene expression, embryonic development, and reproduction. In embryonic stem cells, its loss disrupts the balance between active and repressive histone marks, affecting developmental signaling and gene expression. In cancer biology, ARID4B exhibits context-dependent behavior—promoting tumor growth in PTEN-deficient prostate cancer via activation of PI3K pathway genes—and is also implicated in glioma, breast, and liver cancers. In reproduction, ARID4B functions as an androgen receptor coactivator in Sertoli cells, regulating genes essential for spermatogenesis, germ cell survival, and testicular structure. Overall, ARID4B is a multifunctional chromatin regulator vital for normal developmental and reproductive processes.

The Multifaceted Role of PUM1 in Post-Transcriptional Regulation and Oncogenic Signaling

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Abstract

PUM1 is a member of the evolutionarily conserved Pumilio family of RNA-binding proteins, Pumilio (Pum)/FBF family (PUF), which has emerged as a key regulator of post-transcriptional gene expression with profound implications in cancer biology and apoptosis. Recent studies have expanded the focus beyond transcriptional regulations, demonstrating that PUM1 specifically binds to a conserved RNA sequence motif, UGUAHAUW, located primarily within the 3′ untranslated regions (3′UTRs) of target mRNAs, thereby determining the fate of these mRNAs. Depending on the recruited protein cofactors, PUM proteins can direct their target mRNAs toward translation, repression, activation, degradation, or specific localization. Dysregulated expression of PUM1 is found in numerous cancers including colon, gastric, pancreatic, and ovarian cancers, where it promotes tumor progression by enhancing proliferation, migration, metabolic reprogramming and immune evasion. PUM1 exerts oncogenic effects by repressing tumor suppressor genes such as p27 and modulating key signaling pathways including PI3K/AKT and PERK/eIF2/ATF4, which are in turn linked to apoptosis regulation. Studies suggest PUM1 influences apoptosis by affecting pro- and anti-apoptotic factors at the post-transcriptional level helping cancer cells to evade programmed cell death and develop therapy resistance. PUM1 hence interacts with protein cofactors and non-coding RNAs, shaping complex regulatory networks that control cancer cell survival and apoptotic responses. Studies highlight the potential of targeting PUM1-mediated pathways as novel therapeutic strategies to restore apoptosis and inhibit malignancy.

Sustainable Conversion of Fruit-waste into Biofertilizer for Soil Enrichment and Plant Growth Enhancement

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Abstract

Fruits are an excellent source of vitamins, minerals, and antioxidants, but some fruits produce a massive amount of fruit waste and often get discarded, yet are rich in essential nutrients. Due to improper disposal, the accumulation of fruit waste in the kitchen and at the fruit market poses a significant environmental pollution problem. Therefore, the objective of this study is to address the issue of fruit-waste accumulation by recycling the fruit waste for sustainable conversion into biofertilizer using a solid-state fermentation (SSF) process, allowing us to recycle the fruit waste's nutrients back into the soil. SSF is used for its efficiency in producing biofertilizer in low-moisture environments, so it makes the sustainable conversion of waste into nutrient-rich biofertilizer and applies it to crop plantations to assess the effectiveness of the biofertilizer in the enhancement of soil fertility by analyzing the pH of the soil, essential macronutrients, and microbial growth. And plant growth parameters, including shoot length, root length, and number of leaves. The resulting data will be analyzed statistically to compare different fruit-based biofertilizer treatments. It offers a cost-effective and environmentally sustainable alternative to chemical fertilizers.

Keywords: Fruit-waste utilization, Solid-state fermentation, Sustainability, Biofertilizer

Comprehensive evaluation of polymorphism in SLC11A1 and its association with susceptibility to Tuberculosis

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Abstract

Tuberculosis, a contagious infectious disease caused by Mycobacterium tuberculosis, is a major cause of worldwide mortality, causing over 2 million deaths. SLC11A1- Solute carrier 11 of family 1 (also called NRAMP1- Natural resistance associated macrophage protein 1) plays a key role in macrophage activation and innate immune response. It regulates iron concentration inside phagosomes for Reactive oxygen species production- an important defence mechanism against Mycobacterium tuberculosis. Host genetic variations are studied to understand their contribution to differences in disease susceptibility. GTG repeat deletion in the 3'UTR of the human NRAMP1 gene is associated with increased susceptibility to TB and may lead to reduced NRAMP1 production. Past meta-analysis and case studies have yielded conflicting and inconclusive results. Some studies confirm high risk in Asian populations for 3'UTR variants while some studies confirm effect across ethnicities, not confined to a single population. Based on given reports, we propose an updated Meta Analysis which will help clarifying the role of these genetic mutations towards susceptibility to Tuberculosis. In the current study, an updated Meta Analysis is being conducted.

The multifunctional role of HDAC3 gene in metabolism, neurobiology and cancer

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Abstract

The HDAC3 [Histone deacetylase3] gene codes for a zinc-dependent enzyme that plays a crucial role in the regulation of gene expression by chromatin remodelling. The gene HDAC3 works to remove acetyl groups from histone proteins, which results in chromatin condensation and silencing of gene transcription. Apart from histones, HDAC3 deacetylates non-histone proteins, affecting the cellular pathways like cell cycle control, apoptosis, and metabolism. It has been observed that it regulates various physiological processes, including lipid and glucose metabolism, neural plasticity, and circadian rhythm. HDAC3 is highly expressed in most human tissues, mainly in the brain, liver, and heart. In the liver, HDAC3 maintains lipid homeostasis, and in the nervous system, it promotes learning and memory. HDAC3 is overexpressed in multiple cancers, which leads to tumour growth and repression of tumour suppressor genes. It is also expressed in neurodegenerative conditions such as Alzheimer's and Parkinson's diseases. Complete loss of HDAC3 function is embryonically lethal in mammals. The dysregulation of this gene has been shown in metabolic and inflammatory disorders. In reproduction, HDAC3 is important in gametogenesis and early embryonic development. It controls the gene expression, which is necessary for oocyte maturation, sperm formation, and zygotic genome activation. HDAC3 deficiency disrupts chromatin remodelling during meiosis and embryogenesis, which results in impaired fertility. HDAC3 activity is expressed through post-translational modifications and interactions with co-regulators. So, HDAC3 represents an epigenetic regulator of chromatin dynamics to cellular metabolism, development, and disease.

Keywords: HDAC3, Histone deactylase, cancer, gametogenesis, neurodegenerative, chromatin remodelling

Evaluation of the efficacy of a concoction of Banana Peels, Walnut Shells, and Human Hair as an Affordable Biofilters for treatment of Laundry Waste Water

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Abstract

This research aims to experimentally evaluate the efficacy of natural waste materials—banana peels, walnut shells, and human hair—as biofilters for treating laundry wastewater. The study will involve three test setups, each containing equal volumes of simulated laundry water with consistent contamination levels. Each test tube will be treated with a different biofilter composition: one containing a mixture of all three biomasses, and two others containing combinations of two materials each. These biofilters will be prepared by processing and mixing waste materials into filter media designed to trap dyes, grease, heavy metals, and other pollutants present in laundry effluent. Water will pass through each biofilter, and the filtered samples will be analysed for pollutant removal, including reductions in turbidity, Chemical Oxygen Demand (COD), and heavy metal concentration. Regular monitoring will assess filter performance, pollutant removal efficiency, and filter longevity. It is hypothesized that the tri-material biofilter will exhibit superior overall contaminant removal due to the synergistic adsorption properties of the combined materials, while dual-material filters may show efficiency in targeting specific pollutant classes. The expected findings aim to demonstrate the potential of sustainable, low-cost biofilters made from locally available waste materials to provide an effective treatment option for household laundry wastewater, particularly in resource-limited settings.

Synthesis of a Bi-herbal Formulation of Cucumber Peel and Pumpkin Seeds (Cp-Ps25) and assay of its Antimicrobial Efficacy

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Abstract

Antibacterial resistance (AMR) is a growing global health concern. SDG 3 focuses on good health and wellbeing motivating people to resort to ancient Indian Knowledge System (IKS) like Ayurveda for safer and long-lasting remedies. Use of food waste like peels and seeds offer a natural and eco-friendly way to fight harmful bacteria. The study explores the antimicrobial potential of a combined ethanolic extract of cucumber peels and pumpkin seeds. These materials are often seen as food waste, but they are full of essential nutrients and natural bioactive compounds. Cucumber peels have high amounts of dietary fibre, vitamin C, flavonoids and phenolic acids. Pumpkin seeds are also a good source of proteins, healthy fats, minerals and phytosterols. By designing the bi-herbal formulation, it will enhance the antimicrobial potential and can contribute to sustainability in food and healthcare. The aim of this study is to determine the inhibitory effect of bi-herbal formulation extract against Escherichia coli (Gram-negative) and Staphylococcus aureus (Gram-positive) using the disk diffusion method. The extract is prepared by drying and grinding the plant materials, mixing them in different ratios and soaking them in ethanol with continuous stirring at room temperature to obtain a most efficient herbal formulation. The bi- herbal formulation is expected to show a synergistic effect in which both extracts perform better together than individually. This study highlights an eco-friendly approach for converting plant waste into valuable antimicrobial agents.

Keywords: AMR, SDGs, IKS, Herbal Pumpkin seed, Cucumber peel

Role of LRRC8A in Mammalian Reproduction

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Abstract

The Leucine-Rich Repeat Containing 8A (LRRC8A) gene encodes an important part of the Volume-Regulated Anion Channel (VRAC). This channel helps cells regulate their proper volume by controlling the flow of chloride ions and various other osmolytes. While LRRC8A is specifically known for this crucial role in cellular balance, recent studies have shown its important role in reproductive biology. LRRC8A works with other LRRC8 isoforms to regulate osmotic pressure during crucial reproductive mechanisms like maturation of oocytes, spermatogenesis, and development of early embryo. Using knockout models and gene expression analyses shows that the lack of LRRC8A can affect gamete health and disrupt meiotic progression. This indicates how crucial it is for maintaining and regulating the ionic and osmotic conditions required for fertility. In mammals, LRRC8A is highly expressed in tissues related to reproduction such as the testis and ovary. It helps in cell to cell interaction and creates the microenvironment needed for successful reproduction. LRRC8A controls anion transport at the molecular level, its crucial expression in reproductive tissues, and its increasing importance in reproductive health and fertility issues. Understanding LRRC8A's role may lead to new ways of diagnosing and treating infertility related issues.

Keywords: lrrc8a, reproduction, mammals

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