15TH INDIA JAPAN SCIENCE TECHNOLOGY & EDUCATION SEMINAR

40TH ANNIVERSARY OF INDIA-JAPAN S&T COOPERATION

ICFAST 2025

ABSTRACT BOOK

NIT CALICUT

Message from SUGINO Tsuyoshi, President of the Japan Society for the Promotion of Science

On the occasion of ICFAST-2025, which features the 15th India-Japan Science, Technology, and Education Seminar and the 40th Anniversary Celebration of India- Japan Science & Technology Cooperation, presented by the Indian JSPS Alumni Association (IJAA) on October 10th and 11th, 2025, at the National Institute of Technology Calicut, and on October 12th at the Indian Institute of Technology Delhi, I would like to extend my sincere congratulations to you all.

This year marks the milestone 40th anniversary of the signing of the India-Japan Science and Technology Cooperation Agreement, and this symposium is positioned as a commemorative event within the framework of the India-Japan Year of Science, Technology, and Innovation Exchange. Each year, the symposium attracts a large number of students, researchers, university officials, and industry representatives from both within and outside India, and it is highly regarded as a significant event that drives academic exchange between the two countries. This year, we are especially honored to welcome Nobel Laureate in Chemistry, Dr. Akira Yoshino, who will deliver a keynote lecture, bringing exceptional prominence to the event.

The symposium has always offered a valuable opportunity to engage with cutting-edge science and technology from both countries. Over its history, many individuals have been inspired by the symposium to study in Japan and are now actively contributing as researchers, serving as bridges between India and Japan. I sincerely hope that this year's participants will also deepen their understanding of and interest in Japan, and that the friendship and cooperation between our two countries will continue to grow even stronger.

It is well recognized that the relationship between India and Japan is highly significant across multiple domains, including academic exchange. Numerous joint research projects have been conducted to date, yielding remarkable results. These achievements form a solid foundation for future academic collaboration between our two countries. JSPS has, in close partnership with institutions such as the Department of Science and Technology (DST) of India, long supported joint research initiatives and the organization of seminars. It is encouraging to see that, through these efforts, cooperation between researchers and research institutions in India and Japan continues to deepen steadily.

Since 1995, JSPS has been working to bring together researchers who have received support

through JSPS programs, aiming to form, maintain, and strengthen an international network of researchers. Today, 21 alumni associations have been established around the world, with more than 7,000 members actively involved. The Indian JSPS Alumni Association (IJAA), established in 2006, is the sixth official alumni association, the first in Asia, and notably, the first in a country without a JSPS overseas liaison office. We take great encouragement and pride in witnessing the vibrant initiatives led by IJAA members, inspired by their independent spirit and dedication.

I would also like to express our sincere respect for the invaluable leadership of Dr.Sakthi Kumar, who has served as President of IJAA for many years. The India Japan Society for Science, Technology and Education (IJSSTE), established in 2024 under Dr. Kumar's stewardship, aims to build a broader academic and scientific network between India and Japan, with IJAA members playing a central role. I sincerely hope that the activities of IJSSTE will contribute significantly to deepening the exchange between our two countries. I would like to extend my heartfelt congratulations to Dr. Kumar on receiving this year's Foreign Minister's Commendation of Japan in recognition of his outstanding contributions to academic exchange between India and Japan.

In closing, I wish to express my sincere respect and gratitude to IJAA President Dr. Kumar, Prof. Prasad Krishna, Director NIT Calicut, Prof. M. K. Ravi Varma, Dr. Baiju G Nair and all the dedicated individuals who helped organize this symposium. I wholeheartedly wish for the continued growth of the IJAA and the flourishing of academic exchange between India and Japan.

SUGINO Tsuyoshi
President
Japan Society for the Promotion of Science

Director's Message

Dear Participants,

It is with great joy and pride that I welcome you all to the *15th India-Japan Science, Technology & Education Seminar – International Conference on Frontier Areas of Science and Technology (ICFAST 2025)* at the National Institute of Technology Calicut.

This year's conference is a special occasion for us at NIT Calicut. To host ICFAST 2025, in collaboration with the Indian JSPS Alumni Association (IJAA), is both an honour and a privilege. It reflects our shared belief that science and technology flourish best when ideas travel freely across borders, when knowledge is exchanged openly, and when people from different cultures and backgrounds come together in a spirit of curiosity and friendship.

The India–Japan academic and cultural bond has always been one of mutual respect and inspiration. ICFAST 2025 builds on that tradition by bringing together scientists, researchers, students, and thought leaders from both nations and beyond. This is not just a conference; it is a meeting of minds across generations—where young researchers gain inspiration from leaders in the field, where collaborations take root, and where lasting friendships are forged.

At NIT Calicut, we believe strongly in nurturing such platforms. We see them as opportunities to not only showcase research but also to create dialogue that leads to new questions, fresh perspectives, and meaningful innovations. In a world facing complex challenges, international gatherings like ICFAST remind us that solutions are possible when we think and work together.

I thank IJAA and the Japan Society for the Promotion of Science (JSPS) for their vision and commitment in sustaining this seminar series over the years. I also extend my heartfelt appreciation to the organising team whose dedication has made this event possible.

I warmly invite you to make the most of your time here - share your ideas generously, listen with openness, and carry back with you both knowledge and friendships. I wish ICFAST 2025 great success and hope your experience at NIT Calicut is memorable, inspiring, and rewarding.

With heartful regards,

Prof. Prasad Krishna (D.Eng, University of Michigan)

Director
National Institute of Technology Calicut

IJAA Chairperson's Message

September 25, 2025

I am delighted to invite you to the 15th India-Japan Science and Technology Seminar, organized by the Indian JSPS Alumni Association (IJAA) (www.indianjspsalumni.org) in collaboration with NIT Calicut, taking place on October 10-11, 2025. This event will also serve as our annual gathering.

IJAA is deeply committed to fostering and enhancing science and technology collaboration between India and Japan. Over the years, we have successfully conducted 14 India-Japan S&T seminars across various locations in India, as well as 4 Nobel Laureate Seminars—one in Tokyo and three online. The increasing number of participants in our seminars reflects our progress towards achieving our goals.

This year holds special significance as we celebrate the 40th Anniversary of India-Japan S&T Cooperation and recognize the 2025 academic year as the "Year of India-Japan Science, Technology, and Innovation." We look forward to facilitating even more meaningful collaborations and active cooperation between our two nations in the coming years.

We extend our sincere gratitude to Prof. Prasad Krishna for graciously hosting the 15th India-Japan S&T Seminar at NIT Calicut. We are also thankful to Dr. Baiju G. Nair, Organizing Secretary and his team from our IJAA South Chapter for their efforts in organizing this seminar.

Once again, I warmly welcome all delegates to join us for what promises to be a valuable and enriching experience.

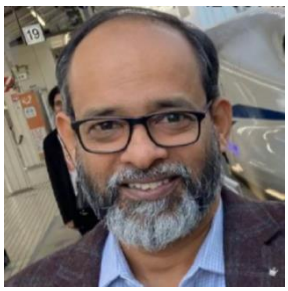
Prof. D. Sakthi Kumar,

Chairman,

Indian JSPS Alumni Association (www.indianjspsalumni.org)

Professor, Faculty of Information Sciences and Arts,

Toyo University, Kawagoe, Saitama, Japan



Message from the Dean

Dear Esteemed Guests, Delegates, Researchers, and Students,

It is a great privilege to extend a sincere and hearty welcome to the International Conference on Frontier Areas of Science and Technology (ICFAST 2025), a special event held to celebrate the "Year of India-Japan Science, Technology, and Innovation Exchange. This conference, organized jointly by the Indian JSPS Alumni Association (IJAA) and NITC, is a landmark event coinciding with the India-Japan Science, Technology, and Innovation Year 2025.

As we gather here in a spirit of shared inquiry and innovation, we mark a significant milestone in the strong and collaborative relationship between India and Japan in the field of Science & Technology. During the ICFAST2025, we will delve into diverse areas, with the goal of fostering cross-cultural partnerships and advancing academic excellence. Also, the gathering represents a unique opportunity to build new collaborations and strengthen existing partnerships between our two nations.

At NITC, we have always been committed to fostering a culture of innovation, research, and global collaboration. The presence of global thought leaders and Nobel Laureates at this conference is a testament to the importance of our shared mission. I trust that your time on our campus will be academically enriching and allow you to experience the rich cultural environment of our institute and the state of Kerala.

My sincere gratitude goes to the organizers, sponsors, and the IJAA for their unwavering commitment to making this event a success. I wish every participant a fruitful and inspiring conference.

Prof. Ravi Varma M K

Dean, International, Alumni and Corporate Relations

NIT Calicut

Welcome Note

It is my great pleasure to welcome you to the International Conference on Frontier Areas of Science and Technology (ICFAST-2025) at the National Institute of Technology Calicut.

As an AJSPS Fellow and a member of the JSPS Alumni Association (IJAA), I extend my sincere thanks to IJAA for giving me the opportunity to host this prestigious event at NIT Calicut.

I am deeply grateful to Professor Sakthi Kumar, Chairman of IJAA, for his trust and guidance. I also express my heartfelt thanks to Professor Prasad Krishna, Director of NIT Calicut and Patron of this event, for his constant encouragement and invaluable support in making this conference a reality.

I am confident that ICFAST-2025 will serve as a vibrant platform for collaboration and knowledge exchange between India and Japan, fostering innovation and building lasting partnerships.

Dr. Baiju G. Nair, Dr. Eng

(MEXT, JSPS, SPDR, BRIDGE Fellow)

Organizing Secretary, ICFAST-2025

NIT Calicut

International Conference on Frontier Areas of Science and Technology (ICFAST 2025)

10-11, October 2025

Jointly Organized by

Indian JSPS Alumni Association and National Institute of Technology Calicut

Kozhikode, Kerala, India

Venue: Swami Vivekananda Auditorium, NIT Calicut

Programme Schedule

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10 October, 2025 (Day 1: Friday)

8:00 - 9:30 hrs	Registration		
9:30 - 11:00 hrs	Opening Ceremony – Inauguration – Felicitations		
11:00 - 11:30 hrs Group Photo Session & Tea Break			
Session I	Chairperson: **Prof. Prasad Krishna**, Director, NIT Calicut		
11:30 - 12:15 hrs	Keynote Lecture-1	**Prof. Yoshino Akira**, Nobel Laureate (2019) Honorary Fellow, Asahi Kasei Corporation *The Future Society Engendered by Lithium Ion Battery*	
12:15 -13:00 hrs	Keynote Lecture-2	**Padma Shri, Prof. E. D. Jemmis** Indian Institute of Science, Bengaluru *Contrasting Structural Chemistry of Carbon and Boron*	
13:00 - 14:00 – Lunch Break			
Session II	Chairperson: **Prof. Satyan Saha**, BHU		
14:00 - 14:30 hrs	Plenary Lecture-1	**Prof. Ravindran P.** Vice-Chancellor, Calicut University *Preparation of Sustained-release Drug-excipient Composites using Supercritical CO_2 as Mixing Medium*	
14:30 - 15:00 hrs	Plenary Lecture-2	**Prof. Hiroshi Abe** Nagoya University *Chemistry-based mRNA Design Enhancing Translation Toward Therapeutics*	"**Igniting Young Minds**" Interaction with School Students with **Prof. Yoshino Akira** *Venue: SOMS hall 104*
15:00 – 15.30 hrs	Plenary Lecture-3	**Prof. A. Jayakrishnan** Former VC Kerala University & CUSAT *Drug Delivery Across the Blood-Brain Barrier: A New Approach*	

		Using Drug-Polysorbate Conjugates	
15:30 – 15.50 hrs	Invited Lecture-1	**Dr. P. K. Hashim** Hokkaido University *Photopharmacology through Molecular Photoswitches*	
15:50 -16:10 hrs Tea Break			
Session III	Chairperson: **Prof. Jose Mathew**, NIT Calicut		
16:10 – 16:40 hrs	Plenary Lecture-4	**Prof. B. Ravi**, Director, NIT Surathkal *Medical Device Innovation for Affordable Healthcare*	
16:40 – 17:00 hrs	Invited Lecture-2	**Prof. Saigusa Hide** IIT Mandi, India	Executive Committee and General Assembly of IJAA members (Invited Members only) *Venue: SOMS Hall 104*
17:00 – 17.20 hrs	Invited Lecture-3	**Prof. M. R. Anantharaman** CUSAT, Kerala *New Non-Van der Waals Solids for Energy Applications*	
17:20 – 17:40 hrs	Invited Lecture-4	**Prof. Kotaro Kataoka** Indian Institute of Technology, Hyderabad *Towards Inter-Blockchain Communication*	
Opportunities in Japan			
17:40 – 17:55 hrs	JST's Programs for/with India (Sakura Science Program/LOTUS Program)	**Mr. Nishikawa Yuji** Advisor, Sakura Science Program HQs. Japan Science and Technology Agency	
17:55 – 18:00 hrs	University of Tokyo	Representative	
18:00 – 18:05 hrs	Kyushu University	Representative	
18:05 -18:10 hrs	Asia Pacific University	**Prof. Fujita Masanori**	
18:30 - 21:00 hrs **Cultural Programmes** **Gala Dinner**			

11 October, 2025 (Day 2: Saturday)

Session IV	Chairperson: **Prof. Darshak Trivedi**, NIT Surathkal	
09:00 - 09:30 hrs	Plenary Lecture-5	**Dr. Sheeja T.E.,** ICAR-IISR Calicut *Metagenomic Insights into Nano ZnO Mediated Shifts in Bacterial Community Structure and Function, Patterns of Resistance Gene Dissemination and Phytoremediation in Soil*
09:30 - 10:00 hrs	Plenary Lecture-6	**Prof. Mako Nakamura** Vice President, Kyushu University *Smooth Muscle Cell Culture for Animal Health and Future Food*
10:00 - 12:00 hrs Tea Break & **Poster Session**		
Session V	Chairperson: **Prof. Dinesh Rangappa**, VTU	
12:00 - 12:30 hrs	Plenary Lecture-7	**Prof. Warisawa Shin'Ichi**, University of Tokyo *Human Sensing and Cross-modal Sensation for Sustainable Well-being*
12:30 - 13:00 hrs	Plenary Lecture-8	**Prof. Nandakumar Kalarikkal** Director, International Centre for Ultrafast Studies. Professor of Eminence in Nanoscience and Nanotechnology, Mahatma Gandhi University, Kerala. *Insights into Contemporary Catalysis for Sustainability*
13:00 - 14:00 hrs Lunch Break		
Session VI	Chairperson: **Prof. Utpal Borah**, Tezpur University	
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14:50 - 15:10 hrs	Invited Lecture-6	**Prof. Eri Ikeda** Indian Institute of Technology Delhi *India's Economic Security*
15:10 - 15:30 hrs Tea Break		

Session VII	Chairperson: **Prof. Bhabani Prasad Mandal**, BHU	
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The Future Society Engendered by Lithium Ion Battery

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The lithium-ion battery (LIB) is a small and lightweight rechargeable battery which greatly contributed to the advent of the mobile IT society. For over 25 years in consumer electronics applications, the LIB's performance and reliability have been improved while its cost has been reduced. Currently the LIB is at a turning point in automotive applications. This will not simply be electrification of vehicle drive systems, but integration with the latest technologies such as IoT, AI, and 5G. This is expected to usher in a major social transformation in terms of the future of mobility.

Global environmental issues are a serious challenge facing all of humanity. Research and development are being conducted across all technological fields to address these issues, with the target year set for 2050. LIB technology is also expected to play an important role. By 2050, numerous innovations will likely have emerged in many technological fields, including the LIB.

Contrasting Structural Chemistry of Carbon and Boron

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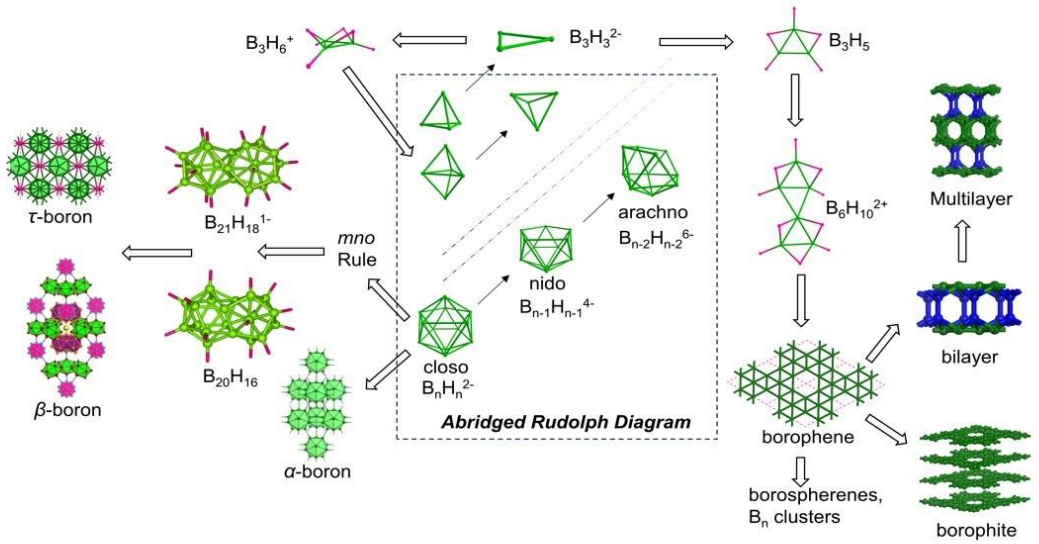
Unlike the well-known structural chemistry of carbon, a general understanding of the structural chemistry of boron is only evolving and our recent attempts in this area using Orbital Engineering will be higlighted here. A large part of the chemistry of boron, can be understood using the analogy to carbon. On the other hand, the unusual stability and aromaticity of $B_{12}H_{12}^{-2}$ and other polyhedral boranes led to the Wade's Rules and Rudolf diagram. The mno Rule relates $B_{12}H_{12}^{-2}$ to 3D allotropes of boron.[1] A closer look at the structural details of compounds and allotropes of boron shows that the repeating pattern in boron chemistry is the three membered ring. The role of three membered rings in borophenes, bilayer and multilayer borohenes, and borophites will be presented.[2-4]



Extended Rudolph Diagram

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Preparation of Sustained-release Drug-excipient Composites using Supercritical CO_2 as Mixing Medium

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Liquid and supercritical CO_2 offer tremendous advantages as a greener and safer solvent platform for the pharmaceutical industry. In this work, we use the CO_2-solvent platform combined with highly CO_2-philic excipient systems (polyethylene glycol, PEG; sucrose octaacetate, SOA; and α-D-glucose pentaacetate, AGLU) to disperse active pharmaceutical ingredients. When treated with CO_2, the excipients undergo profound structural modifications relative to those processed using the conventional liquid solvents, ethyl acetate and acetone. Of particular interest is the glass formation of sucrose octaacetate. Kinetics of drug release from excipient systems processed using CO_2 and conventional solvents were compared, and a mechanism for the observed differences is provided. Drug-excipient composites composed of binary excipient mixtures including SOA/AGLU, PEG/AGLU, and SOA/PEG of varying compositions are prepared. The CO2-processed, binary excipient systems were shown to offer tunable, sustained release kinetics that depended on their composition.

The results indicate that CO_2 solvent, combined with CO_2-philic excipients, offers a novel, green approach to process APIs for oral administration with tunable sustained release profiles.

A few other applications of the CO2-solvent platform will also be discussed.

Chemistry-based mRNA Design Enhancing Translation Toward Therapeutics

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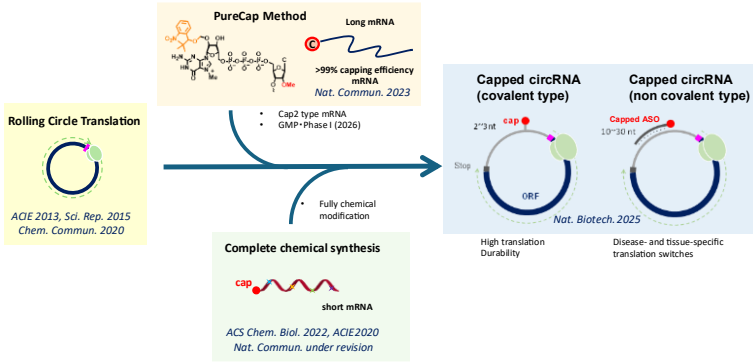
Messenger RNA (mRNA) production has traditionally relied on biological transcription reactions, yet chemical modification approaches offer new opportunities to optimize mRNA functionality. Modifications such as the incorporation of methylpseudouridine to mitigate immune stimulation, alteration of the poly(A) tail to improve stability and translation, and chemically modified cap structures have been widely explored. In our previous work, we developed the PureCap method, which employs a hydrophobic tag on a cap analog for efficient reversed-phase HPLC purification of mRNA, yielding high-purity products. However, site-specific modifications remain challenging with enzymatic transcription, prompting the development of complete chemical synthesis methods. Using a nucleic acid synthesizer, we achieved 5′-phosphorylated RNA synthesis and high-efficiency capping with a novel reagent, enabling the total chemical synthesis of mRNA. To overcome limitations of conventional designs, we recently advanced an internal cap-initiated translation (ICIT) strategy for circular mRNA. In this approach, an m7G cap is introduced internally, either via covalent attachment onto a branched RNA element (cap-circ mRNA) or by non-covalent tethering using an m7G-modified complementary oligonucleotide (cORN). Both strategies dramatically enhance translation efficiency, with cap-circ mRNA achieving up to 10^3-fold higher protein expression than uncapped variants. Moreover, when combined with N1-methylpseudouridine modification, these constructs exhibit robust, durable protein synthesis in cells and in vivo while minimizing innate immune activation. Overall, our integrated approach—combining chemical synthesis, site-specific modifications, and innovative ICIT strategies—provides a versatile platform for next-generation mRNA therapeutics. This strategy not only enhances translational efficiency and mRNA stability but also reduces immunogenicity, making it a promising candidate for applications such as mRNA vaccines and cancer immunotherapies.



Drug Delivery Across the Blood-Brain Barrier: A New Approach Using Drug-Polysorbate Conjugates

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Targeting therapeutic agents to the brain to treat central nervous system (CNS) diseases is a major challenge due to the blood–brain barrier (BBB). Recently, we have made an attempt to deliver a model drug such as doxorubicin (DOX), to the brain in a mouse model through DOX-Polysorbate 80 (DOX-PS80) conjugates. DOX was successfully conjugated with PS80 by carbamate linkage and the conjugate was characterized by different spectroscopic techniques, such as FTIR, UV-Visible and NMR. The DOX conjugation efficacy was found to be 43.69 ± 4.72%. The *in vitro* cumulative release of DOX from the conjugates was found to be 4.9 ± 0.8% in PBS of pH 7.3 and 3.9 ± 0.6% in simulated cerebrospinal fluid (CSF) of pH 7.3 at the end of 10 days. An *in vitro* BBB permeability assay was carried out using bEnd.3 cells and DOX-PS80 conjugate showed a 3-fold increase in BBB permeability compared with controls. *In vitro* cytotoxicity assay using U251 human glioblastoma cells showed an IC50 value of 38.10 μg mL^{-1} for DOX-PS80. Cell uptake studies revealed that DOX-PS80 was effectively taken up (90%) by the bEnd.3 and U251 cells and localized in cytoplasm at the end of 24 h. Pharmacokinetic parameters for DOX-PS80 were evaluated using *in silico* studies. Tumour spheroid assay and *in vivo* experiments in Swiss albino mouse demonstrated the possibility of DOX-PS80 conjugate crossing the BBB and delivering the drug molecules to the target site for treating CNS disorders. This model opens up the possibility of using drug-PS80 conjugates for targeting the brain.

Medical Device Innovation for Affordable Healthcare

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Modern healthcare relies on a wide range of medical equipment and devices for screening, diagnosis, treatment and rehabilitation. At present, most of these equipment are imported at high cost, making them unaffordable to the majority of the population in low-income countries. New technologies such as biocompatible materials, 3D CAD, 3D printing, miniature sensors and Internet of Things, provide new opportunities for innovation in the medical field, yielding better, faster and more affordable diagnosis or treatment. This however, requires close collaboration between researchers and engineers from multiple disciplines (biomedical, design, electronics, mechanical, materials, manufacturing, software, quality, etc.). In this talk, illustrated by indigenous stories, we will show how such interdisciplinary teams can traverse the pathway from *defining* an unmet medical need (bedside), *developing* a novel product (bench), *delivering* a validated device (business) and *deploying* it in clinical practice (bedside). We will examine various challenges and best practices for navigating the 'valleys of death' between idea, invention, innovation and impact. Key elements of the ecosystem for creating multiple success stories will also be shared, based on the experience at the Biomedical Engineering & Technology Innovation Centre (BETIC), IIT Bombay.

Metagenomic Insights into Nano ZnO Mediated Shifts in Bacterial Community Structure and Function, Patterns of Resistance Gene Dissemination and Phytoremediation in Soil

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Nano zinc oxide (nZnO) is one of the most potent metal contaminant in the soil. Yet its ecotoxicological impacts on soil bacterial communities remain unexplored. Soil bacterial community structure and functional shifts and resistance gene dissemination were explored across a range of concentrations (0–1000 mg Zn kg^{-1}) and compared with its bulk counterpart (bZnO). A sharp decline in soil microbial end points and bacterial diversity was observed with greater impact under nZnO. Stress-resilient phyla (e.g., Proteobacteria, Bacteroidetes) and genera (*Nitrospira, Bryobacter, Sphingomonas*, and *Flavisolibacter*) showed a dose dependent variation. Bacteria adapted to high Zn stress by deploying key functions in distant and different taxa leading to Taxon-function decoupling, with reduced resilience observed under nZnO. Analysis of Zn homeostasis genes (ZHGs), indicated disruption of homeostasis at high levels of 500 and 1000 mg Zn kg^{-1} with nZnO showing overrepresentation of major influx systems like *ZnuABC* and attenuation of efflux systems like CzcCBA and *ZntA*, eventually leading to greater accumulation of intracellular Zn. nZnO promoted genes related to exopolysaccharide biosynthesis and attachment, while bZnO favored capsule formation, chemotaxis and biofilm dispersion indicating a better stress avoidance mechanism under the latter. Zn could be identified as a stronger driver of the resistome, promoting the proliferation of antibiotic resistance genes (ARGs), especially those conferring multidrug resistance and resistance to last-resort antibiotics like vancomycin. Rhizosphere of turmeric plants at 1000 mg Zn kg^{-1} indicated a downregulation of ARGs, due to their unusual ability to accumulate Zn within the vascular tissues. However, lower levels up to 500 mg Zn kg^{-1} as nZnO was found to be stimulatory and enhanced the expression of key biosynthetic genes for curcumin.

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Smooth Muscle Cell Culture for Animal Health and Future Food

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＜Three Types of Muscle＞What comes to mind when you hear the word “muscle”? Probably, skeletal muscle, the primary structural part of the body. In Japan's super-aged society, we often meet information about skeletal muscle in our daily lives. Beyond these easily recognizable skeletal muscles, our bodies have two other types: cardiac muscle, responsible for the heart's contractions, and smooth muscle, found in blood vessels, the digestive tract, and elsewhere, which transports substances through sustained, gentle contractions. The proper functioning of these three types of muscle is essential for sustaining life.

＜Muscle Cell Differentiation and Its Dysfunction＞Among the three types of muscle, I am particularly interested in the development and differentiation of smooth muscle, as well as their genetic regulatory mechanisms. Currently, I am focusing on researching genes involved in the dysfunction of smooth muscle cell differentiation using stomach of chicken embryos. In my laboratory, we are advancing gene expression analysis by comparing a contractile (differentiated) model using serum-free culture medium with a proliferative (dedifferentiated) model using medium supplemented with serum.

＜Cell-Based Agriculture and Muscle Research＞ From the perspective of animal science, skeletal muscle is recognized as edible meat. On the other hand, cardiac and smooth muscles are referred to as animal by-products within the field. The utilization of these by-products for meat is limited, and most are processed as animal waste. I aim to apply smooth muscle research to the meat conversion of livestock waste, specifically to the production of cultured meat, which is gaining attention as one form of cell-based agriculture. We are currently exploring cells using chicken embryonic stomach that could serve as seeds for cultured meat.

Human Sensing and Cross-Modal Sensation for Sustainable Well-Being

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This presentation introduces an integrated approach for achieving sustainable well-being by combining everyday human sensing technology with sensory augmentation technology. The goal is to develop a system platform that enhances physical and mental health by continuously monitoring an individual's state and providing feedback for improvement.

The first half focuses on "Daily sensing", which non-invasively monitors physiological and psychological states during daily life. Key projects include: 1) Continuous Blood Pressure Monitoring: A cuffless system. Tracks short-term blood pressure fluctuations using electrocardiogram (ECG) and pulse wave sensors. Crucial for assessing stroke and heart attack risk, particularly in elderly care. 2) Stress-Sensing Cushion: A device that analyzes changes in sitting posture and movement patterns during desk work to estimate chronic stress levels. Measures using pressure sensors embedded in the cushion. 3) Daily Cognitive Function Monitoring: The "DailyExp" tool. Regularly measures cognitive functions like fluid intelligence and attention while collecting physiological data from wearables like Fitbit.

The latter part pursues "Augmentation for Well-being", using cross-modal sensory feedback to transform human perception and induce desirable states. Key research includes: 4) Wind sensation generation: Wind perception is a multisensory experience involving vision, hearing, touch, and temperature. "AlteredWind" manipulates wind direction using VR and 3D audio, while 'VWind' stimulates the ears with vibration and temperature changes to generate an "illusion of wind" without actual airflow. 5) Tactile/Somatosensory Feedback: "FurAir" provides a non-contact sensation of stroking soft fur using ultrasound, while "Relaxushion" induces breathing rhythms through cushion expansion and contraction. This suggests potential for enhancing cognitive function.

It is aimed to integrate these perception and augmentation technologies to build feedback loops that support effective rest, active work, and overall well-being.

Insights into Contemporary Catalysis for Sustainability

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In light of the energy and environmental concerns stemming from fossil fuel depletion and growing concern over environmental pollution, we need to explore alternative ways for sustainable and eco-friendly approaches. Catalysis has become an integral part of our day to day lives essential to make all the goods surrounding us, including fuels, coatings, plastics and other functional materials focusing much on energy and water security. It is very much evident that in the near future, catalysis will also be an essential tool in making the shift from a fossil-fuel-based to a more renewable and circular society. The literature depicts that the global revenue of the chemical industry in 2019 amounted to an approximate US$4 trillion, of which an estimated 85% involved catalytic processes. In this talk, our very recent works about the design of novel photocatalysts for water purification and electrochemical catalysts for addressing the future energy requirements will be discussed.

Keywords: Catalysis, Water purification, Hydrogen generation, MXenes, Laser Matter Intercation

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Prospects for India–Japan Academic and Research Collaborations

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India and Japan, two knowledge-driven economies with complementary strengths, hold significant potential for deepening academic and research collaborations. India's young demographic profile, growing higher education ecosystem, and global leadership in information technology converge with Japan's advanced research culture, technological innovation, and strong industrial base. Together, they form a partnership capable of addressing national priorities while contributing to global challenges.

Over the past two decades, bilateral cooperation has gained momentum through joint initiatives of the Japan Society for the Promotion of Science (JSPS), Department of Science and Technology (DST), and other agencies. Collaborative projects in robotics, materials science, renewable energy, and artificial intelligence demonstrate the potential of such cooperation. Frameworks such as India's National Education Policy 2020 and Japan's "Society 5.0" vision provide a policy environment conducive to academic exchange, joint research, and institutional partnerships.

The prospects ahead are shaped by three major drivers. First, India's young research community offers global engagement opportunities, complementing Japan's need to offset demographic decline. Second, the rise of frontier technologies—quantum computing, green hydrogen, nanotechnology, and sustainable agriculture—demands collaborative, multidisciplinary approaches. Third, shared commitments to the Sustainable Development Goals (SDGs) create space for joint efforts in climate resilience, water security, and sustainable urban systems.

Challenges persist in the form of funding constraints, linguistic barriers, and differing academic governance systems. Addressing these requires enhanced mobility programs, streamlined visa processes, digital collaboration platforms, and dedicated bilateral research funding.

The India–Japan academic partnership is thus poised not only to strengthen bilateral ties but also to emerge as a model of transnational collaboration for the 21st century. ICFAST 2025 provides an ideal platform to deliberate on pathways that can transform this partnership into a long-term driver of innovation and global sustainability.

Keywords: India–Japan collaboration, higher education, research partnerships, innovation, sustainable development

Translational 3D Bioprinting for Advancing Healthcare

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With the rapid developments in biofabrication and biomaterials technologies, it is now increasingly feasible to engineer biomedical products and implants that can markedly enhance tissue repair and regeneration while enhancing the ease of surgical procedures. Additive manufacturing and 3D printing can be used to fabricate implants and tissue scaffolds of complex architecture, which are personalized to meet the patient's needs. In this talk, I will highlight our recent efforts in fabricating personalized implants and scaffolds of complex geometries for the regeneration of soft and hard tissues. These technologies can be further combined with smart materials and design to prepare 4D-printed deployable devices.

Advanced Biomedical Applications of Raman Spectroscopy

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Recent development in microscope coupled Raman spectroscopy has enabled us to study tissues and living cells in situ. In Shimane University, we are working on biomedical applications of Raman spectroscopy. In this presentation, I introduce our works for Biological Applications of Raman spectroscopy. As one of such applications, I introduce time and space-resolved Raman imaging study on the metabolism of fission yeast supported by the technique of non-negative restricted multivariate curve resolution analysis.

Fission yeast (*Schizosaccharomyces pombe*) repeats somatic division in the medium with enough nutrition. However, if the medium lacks, especially in nitrogen resources, yeast cells stop division at G1 stage to form zygotes followed by reduction division to form four spores in each zygote. The spore wall is assumed to be covered by sugar coat, however the details of the coat are not well known yet. Thus, we have followed the procedure of the spore formation using Raman spectroscopy as a probe. We used L968 (mating type h90) fission yeast strain, which naturally converts to plus and minus mating type, thereby can mate and form spores within a strain. The strains were incubated for ~50 hours at 26ºC and were taken for Raman spectral measurements in a compatible glass bottom dish. Raman spectra were measured for both vegetative cells and spores. We used a homemade Raman spectrophotometer equipped with a He-Ne laser. The laser power at focal point was 2.1 mW with an exposure time of 1 second. Raman spectra were measured with a step size of 0.6 μm to get Raman image. By applying univariate and multivariate analyses to Raman spectral data, we have found that the composition of sugars in vegetative membrane and spore wall is different; β-glucan is found in the vegetative wall, however it is not found in the spore wall [1]. Detailed procedure in analysis will be introduced in the presentation.

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Photopharmacology through Molecular Photoswitches

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Over 85% of small molecule drugs fail in clinical trials due to poor selectivity and side effects. Photopharmacology offers a promising solution by enabling spatiotemporal control over drug activity using light-responsive molecules called photoswitches (Figure 1). Traditional photoswitches, such as azobenzenes, often require ultraviolet (UV) light for activation, which is cytotoxic and has poor tissue penetration. To overcome this, recent research focuses on visible-light-activated photoswitches based on heteroaryl scaffolds like thiazole, which offer improved photophysical properties and biocompatibility. This talk highlights the development of such visible-light-responsive switches for future photopharmacological applications.

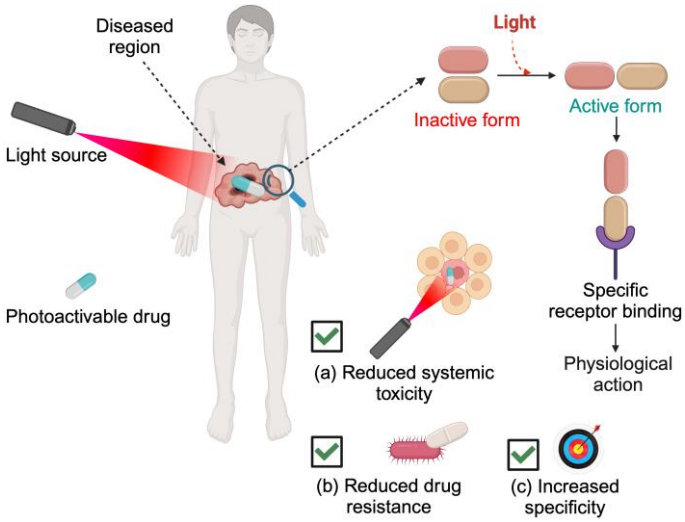

Figure 1: Scheme showing the concept of photopharmacology

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New Non-Van der Waals Solids for Energy Applications

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The successful extraction of graphene from Graphite by Andre Geim and Konstantin Novoselov opened up new areas in the realm of materials science. The subsequent investigations led to the discovery of new 2D materials namely hexagonal boron nitride (h-BN), transition metal dichalcogenides (TMDs), layered transition metal oxides, inorganic graphene analogues such as silecene, germanene and phosphorene and many others. One of the attributes of all the above materials is that they are layered in their bulk form wherein the individual layers are held together by van der Waals forces of attraction. This is considered as a precursor to the development of van der Waals (vdW) solids. Exfoliating atomically thin layer from non-layered precursors was not attempted much as evident from literature. We embarked on an investigation into extracting atomically thin layers from their non-layered precursors. In this talk, we will discuss the exfoliation of two new 2D materials namely Hematene and Ilmenene from their naturally occurring ores. The talk will also cover some of the recent investigations that we have carried out on their applications especially on their magnetically ordered ground state as well as fabrication of a heterojunction with titania nanotubes for enhanced visible light photoelectrocatalytic water splitting. These results will be presented here.

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Towards Inter-Blockchain Communication

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Given the emergence of many Blockchain implementations, the preparedness for Inter-Blockchain Communication (IBC) is a critical matter for a single decentralized application operating across multiple Blockchains. However, each Blockchain has its own architecture, consensus mechanism, smart contract capability, signature scheme, etc. those may not be compatible with other Blockchains. While there are several IBC approaches such as "Asset Transfer" and "Atomic Swap", this research pursues "Ownership Transfer and Execution (OTEx)" which is yet another approach. This presentation covers the brief overview of IBC, the latest development of OTEx and its future roadmap. The OTEx development has gone through 2 phases: Ethereum to Ethereum (Phase 1), and Ethereum to Hyperledger Fabric (Phase 2). While the phase 1 focused on enabling the concept of OTEx between two Ethereum networks those basic mechanisms are same with each other, the phase 2 addresses the challenges of overcoming disparity between permissionless and permissioned Blockchains. Our core deliverable is the protocol suite of OTEx that enables IBC, which work as a common language among multiple Blockchains with guaranteeing the validity and trustworthiness of cross-chain transactions. This presentation also address the performance aspect of the protocol suite when it's deployed in the real-world Blockchain networks.

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Teaching physics in Japan and India

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After retiring from Sophia University in Japan, I have been spending nearly five years teaching physics in India. The first 3.5 years at the Indian Institute of Technology, Delhi, and more than a year at the Birla Institute of Technology and Science, Pilani, Goa Campus. I have been one of the few Japanese faculty members in science and engineering in India, and the only one ever in physics. I also gave short physics courses during the summers in Kashmir and other places.

Overall, the experience has been stunning and mesmerizing. I have been most impressed by the fact that nearly 100% of the students study seriously at those schools in India. That is not the case AT ALL for Japanese universities, even the best ones. Nevertheless, not all is well in Indian Universities, particularly due to the severe competition, excessive career-mindedness, students' extreme concerns about marks and grades, and their tendency to equate studying with exam preparation.

In addition to impressions and anecdotes from my own experience, issues regarding the framework of exchange and interface between the Indian and Japanese educational systems will be discussed, also with some reference to the American system. Of particular interest are the undergraduate curricula and admission requirements.

India's Economic Security

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The economic coercion, so-called 'weaponisation of trade'[1], by the leading economies has been increasing with the rise of protectionism and export controls. India is also getting affected by such coercion, and a clear example is seen in the recent imposition of US tariffs. Globally, there is a growing recognition that the economy needs to be insulated from such external negative influences by ensuring self-reliance, strategic autonomy, and strategic indispensability [2]. The present study analyses these aspects in the context of India and attempts to understand the current state of India's economic security. It will further draw an implication for the economic cooperation, with a particular focus on the Japan-India relationship. It will argue that India's idea of economic security is deeply rooted in its history and policy implementation. Self-reliance is one of the most important agendas since the COVID-19 pandemic, and the industrial policy has long been focused on protecting the domestic industry. The heart of India's foreign policy is strategic autonomy, and with this principle, India has been navigating the relationship among the large economies with no-alignment (Prime Minister Nehru era) and multi-alignment (Prime Minister Modi era) [3]. Due to the weakness in the manufacturing sector, India has not been able to develop its indispensability in the global economic system, while its geopolitical and geoeconomic importance is growing, especially for like-minded countries. Japan and India, as the two major economies in Asia, could play a crucial role in stabilizing the Asia-Pacific region by enhancing diversification and mutual strength.

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Identification of Hub Gene Signature Based on Estrogen Signaling Pathway for Predicting Survival and Immune Responses of Patients with Cervical Cancer

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Cervical cancer is the fourth most prevalent malignancy among women especially in developing countries. The major concern on the poor diagnosis and prognosis in cervical cancer has led to the discovery of various biomarker/prognostic signatures and individualized precision therapy strategies recently. As estrogen signaling (ES) is intricately linked to various gynecological cancers, the study aims to create a new ES signature gene for assessing drug and immunotherapy response and prognosis of cervical cancer patients. The TCGA data was analyzed for differentially expressed genes, and subsequently, 12 signature genes were identified via Cox and lasso regression analysis. The prognostic risk model based on those 12 signature genes was constructed and validated with other datasets. The prognostic risk model's survival prediction shown a poorer survival rates in high risk group and similar observation were obtained in the validation dataset too. The predictive value of genes assessed using time dependent receiver operating characteristics, nomogram prediction and decision curve analysis. Consistent results were observed with training and validation datasets with risk score and survival ROC demonstrating strong predictive performance (AUC > 0.7). The Cox regression analysis revealed that the clinical variables age and stage had a significant influence on the model. Gene set enrichment analysis proved that the oncogenic pathways including Wnt signaling, apoptosis, hedgehog signaling were highly enriched in high-risk group. The validation of the signature genes were also accessed through single cell transcriptomics which shows the HPV integration on epithelial and macrophages effect the expression of estrogen signaling which could lead to tumor progression. Our study thus identified and validated estrogen-signalling-related signatures in cervical cancer which could predict the prognosis for cervical cancer and characterize key factors in cancer pathogenesis and therapy.

Evolutionary Insights into the Tyrosinase Enzymes Across Different Lineages

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Tyrosinase, a key enzyme in the biosynthesis of melanin pigment, are widely distributed in animals, bacteria, and fungi. They belong to the type-3 copper protein family along with hemocyanins. These copper metallo proteins catalyze the o-hydroxylation of monophenols into o-diphenols and the further oxidation of o-diphenols to o-quinones.The tyrosinase family include tyrosinase (tyr), tyrosinase related protein-1 (tyrp1) and tyrosinase related protein-2 (tyrp2). Amongst them, tyr plays the crucial role for melanin production, by converting tyrosine to 3,4 dihydroxyphenylalanine (DOPA), while tyrp1 and tyrp2 function in subsequent steps. However,these three tyrosinase family proteins share some structural characteristics. The tyr protein contains two highly conserved metal binding domains, CuA and CuB, that are involved in the proper folding of the active site and in the binding of metal cofactors. To gain a comprehensive understanding of the relationships between tyrosinases among different melanin producing organisms, this work investigated protein sequences coding for tyrosine monophenol oxygenases (tyr) from different lineages. These sequences were retrieved from different databases. A multiple sequence alignment was performed by MUSCLE software to explore potential similarities between all these tyr proteins. A phylogenetic tree was constructed using PhyML, based on multiple sequence alignment generated with MUSCLE, to analyze the evolutionary relationships. In addition, the conserved sequences in the copper binding site of tyr proteins were compared among the organisms which might shed light on the tyrosinase activity in highly efficient melanin producers.

Dihydronitidine: A Potent Drug Candidate Against Multidrug-resistant *Acinetobacter baumannii*

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The emergence of multidrug-resistant (MDR) bacteria is a significant challenge in health care settings due to their ability to acquire resistance against a broad class of antibiotics. *Acinetobacter baumannii* has evolved into a significant pathogen in hospital settings due to its unusual capability to acquire resistance to multiple antibiotics. As the demand for novel antibacterial agents grows, plant-derived bioactive compounds are being recognized as agents with significant therapeutic potential. In the present study, we explored the interaction of a phytocompound, Dihydronitidine, with multiple target proteins of *Acinetobacter baumannii* to identify potential inhibitors through a comprehensive in silico analysis. Dihydronitidine was docked against multiple target proteins of *A. baumannii* associated with pathogenesis and antibiotic resistance pathways, with the ADC-7 β-lactamase protein showing the highest binding affinity, suggesting significant possibilities for inhibitory actions. The ligand–protein complex's structural visualization and two-dimensional interaction mapping showed substantial interactions that retain Dihydronitidine reliability in the protein's active region. ADMET analysis indicated promising pharmacokinetic properties and reduced toxicity risk, supporting the potential of Dihydronitidine for further development as an antibacterial agent against multidrug-resistant *A. baumannii*. This integrated in silico analysis indicates that Dihydronitidine has a high binding affinity for the Protein ADC-7 β-lactamase, exhibits good interaction stability, and has good pharmacokinetic properties and safety profile. This study serves as a basis for experimental validation and indicates the utility of computational methods in plant-derived compound discovery and optimization for key bacterial protein inhibition. With the finding that natural products can serve as viable agents against multidrug-resistant *A. baumannii*, these outcomes can help to advance structure-based antimicrobial drug discovery.

Production of Green Hydrogen via consolidated Bioprocessing of Lignocellulosic Biomass using a Nanobiotechnology Approach

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The primary objective of this research was to develop an environmentally sustainable process for hydrogen production by integrating nanotechnology with consolidated bioprocessing (CBP) using lignocellulosic biomass (LCB). In this study, peroxidase-mimicking $CeFe_3O_4$ nanoparticles (NPs, 4.0 g/L) were utilized to degrade lignin in raw corn cob (CC) biomass, resulting in the generation of cellulose-hemicellulose fractions conducive to *Clostridium cellulovorans* during the fermentation process. The NP-treated biomass demonstrated a 43.26% reduction in lignin content from raw CC, which was subsequently employed for hydrogen fermentation by C. cellulovorans using the CBP approach. The strain yielded a maximum cumulative hydrogen volume of 78.45 mL, with a hydrogen production rate of 1.55 mL/h using NP-treated CC. This study represents the first investigation into enhanced hydrogen production using NP-treated CC biomass in a single-pot fermentation setup, offering a potentially simpler, more accessible, and cost-effective process.

Formulation of Polyvinyl Alcohol- Carbopol Gel loaded with Melaleuca alternifolia Oil: An Antimicrobial Targeted Study

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The rise in antimicrobial resistance underscores the need for effective and natural alternatives to conventional commercial drugs in the market. Delayed wound healing is mainly due to the occurrence of opportunistic pathogens such as Bacillus subtilis and Salmonella typhimurium, which can colonize the damaged tissues by impeding tissue regeneration and elevating the risk of secondary infection. The current work evaluates the antimicrobial efficacy of Melaleuca alternifolia oil against these two pathogens, followed by its molecular docking to explore the molecular interactions with microbial targets. Antimicrobial studies confirmed the pronounced broad-spectrum activity against Gram-positive and Gram-negative strains tested. Molecular docking analyses demonstrated significant binding affinities of major constituents of M. alternifolia oil (terpinen-4-ol, p-cymene, γ-terpinene, α-terpinene) with protein targets from the tested microbes, indicating the inhibition of key microbial enzymes and structural proteins involved in bacterial survival and wound colonization. A topical gel has been formulated incorporating M. alternifolia oil with varying concentrations of polyvinyl alcohol, tested and evaluated, showing promising antimicrobial inhibition, especially in those formulations with an optimized polymer-oil ratio. These findings confirm the potential of M. alternifolia oil for its potential in inclusion as a topical antimicrobial gel. Overall, this study might also highlight the oil's relevance in developing a plant-based therapeutic formulation for infection control if further studies on optimization, formulation stability, and clinical applications were conducted.

India's footprint in Polar Microbiology: Focus on Indian sector of Southern Ocean & Arctic fjord.

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The National Centre for Polar and Ocean Research (NCPOR), under the aegis of the Ministry of Earth Sciences (GoI), is the nodal agency in the country for all polar related research activities. As India's Gateway to Polar Regions, NCPOR has been carrying out multidisciplinary, multi-institutional, and multi-collaborative research activities in the Antarctica, the Indian sector of Southern Ocean (ISSO), and the Arctic. NCPOR, which has been involved in conducting & managing Antarctic expeditions since 1981, recently celebrated 25 years of its establishment as a full-fledged Polar Research Institute. NCPOR has established 2 year round research bases, namely Maitri & Bharati, in Antarctica & one research station "Himadri" in Svalbard archipelago. NCPOR has also conducted 12 expeditions in the ISSO since 2004.

Polar Microbiology- which includes bacterioplankton and phytoplankton studies, has been an integral component of NCPOR's research activities, addressing biodiversity, microbial interactions with phytoplankton & dissolved organic matter, their role in biogeochemical processes, ligand production, and response to climate change. In this talk, a synthesis of the major microbiological work carried out in the ISSO and the Arctic waters is discussed, highlighting NCPOR's microbiological research contribution to global polar microbiological research. Furthermore, the significance of the outcomes of these research activities in addressing some of the major themes of climate research as outlined in "UN Decade of Ocean Science for Sustainable Development", Southern Ocean Observation System (SOOS), and International Arctic Science Committee (IASC) is also discussed. The major challenges in conducting Polar microbiology research and future opportunities are also presented.

Keywords: Polar Microbiology, NCPOR, Antarctic, Southern Ocean, fjords.

Synergistic Approach using Chitosan Encapsulation and Complement-Mediated Opsonization for Efficient Oral Fish Vaccination

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Aquaculture is one of the fastest-growing food production sectors globally. According to a 2024 report by Food and Agriculture Organization (FAO), India and Japan ranked 2nd and 14th in aquaculture production, yielding approximately 10 million tons and 617 thousand tons, respectively, while China led with 53 million tons (1). Despite this growth, infectious diseases remain a critical challenge, significantly impacting productivity and sustainability. Vaccination is a key preventive strategy, with administration routes including injection, immersion, and oral delivery. Among these, oral vaccination is the most desirable due to its ease of application and reduced stress on fish. However, its efficacy is often limited by degradation of antigens in the gut environment and inefficient uptake by intestinal immune cells (2).

This study explores a novel approach to enhance oral vaccine efficacy by leveraging the fish complement system. Specifically, we developed a chitosan-based vaccine delivery vehicle coated with complement protein C3b. Chitosan encapsulation protects the vaccine from gastric degradation, while surface coating with the opsonin C3b is expected to promote antigen uptake by intestinal macrophages, thereby enhancing immune activation (3,4).The proposed strategy represents an innovative step toward overcoming current limitations in oral fish vaccination and holds promise for the development of more effective and commercially viable oral vaccines for sustainable aquaculture.

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Advances in Tenogenic and Stem Cell Therapies for Tendon Regeneration

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Tendon injuries persist as a significant clinical challenge due to the tissue's limited self-healing capacity and the complex architecture of tendon matrix. Recent advances in regenerative medicine have positioned tenogenic and stem cell-based therapies at the forefront of tendon repair strategies. Mesenchymal stem cells (MSCs) hold particular promise owing to their inherent ability to differentiate into tenocyte-like cells and their secretion of regenerative cytokines and growth factors. The modulation of MSC fate through hypoxia-induced pathways, notably involving hypoxia-inducible factor-1-alpha (HIF-1α) and transforming growth factor-beta 1 (TGF-β1), has shown potential to enhance tenogenic differentiation and promote structural and functional tendon regeneration. The clinical adoption of biomaterial scaffolds with aligned topographies has been shown to direct cell migration, proliferation and matrix synthesis, as well as to modulate the secretome of human adipose-derived stem cells (hADSCs), offering synergistic opportunities for improved tendon healing.

The therapeutic landscape is further enriched by emerging knowledge of tendon-derived stem cells (TDSCs), which demonstrate multi-lineage potential and are increasingly recognized for their role in tendon homeostasis and repair. Optimized culture conditions, advanced immunophenotyping, and scaffold integration techniques have expanded the applicability of both MSCs and TDSCs, highlighting their complementary value in tissue engineering. Ongoing research into the cellular microenvironment, immunomodulatory effects and molecular signaling pathways continues to refine these approaches, aiming for reproducible and effective protocols that bridge laboratory innovation with clinical translation. These advances underscore the substantial promise of tenogenic and stem cell therapies in restoring tendon function and offer new hope for patients with challenging tendon injuries.

Key words - Tendon regeneration, tenogenic differentiation, mesenchymal stem cells, hypoxia-inducible factor-1-alpha, tendon-derived stem cells

Elucidation of Tolerance Mechanism in Contrasting Sesame Genotypes under Waterlogging Stress

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Sesame (*Sesamum indicum* L.), a member of the Pedaliaceae family, is one of the oldest oilseed crops with broad nutritional value. Among abiotic stresses, waterlogging (WL) poses a critical threat, severely impairing sesame growth and productivity. WL triggers a metabolic shift from aerobic to anaerobic respiration leading to reduced energy production, stunted growth, and yield loss. To elucidate the underlying mechanisms, the present study investigated WL responses in sesame root tissues. ROS accumulation was first quantified in tolerant (EC377024) and susceptible (IC129289) genotypes. Under WL stress, antioxidant enzyme activities SOD, CAT, APX and MDA content significantly increased in the tolerant genotype at 24 h and 48 h including the recovery phase. Histochemical assays such as DAB, NBT and lipid peroxidation confirmed elevated hydrogen peroxide, superoxide anion generation, and lipid damage with greater damages observed in the susceptible genotype. Root system architecture (RSA) analysis revealed significant differences ($p \leq 0.05$) in adventitious roots, root length, and lateral root development in the tolerant genotype and check (PB-Til 2) suggesting adaptive plasticity for survival. Microtome analysis further demonstrated increased aerenchyma formation in the tolerant genotype with prolonged stress, facilitating survival under WL. Expression profiling showed significant induction of ethylene-responsive (*ERF RAP2-7, ERF-7*), *peroxidase*, and *RBOH-C* genes in the tolerant genotype throughout the stress period. Collectively, these findings indicate that the tolerant genotype withstands WL stress through enhanced antioxidant defense, upregulated ethylene-responsive genes expression as well as aerenchyma formation. This genotype therefore holds strong potential for use in sesame crop improvement through breeding programs.

Keywords: *Sesamum indicum,* waterlogging stress, microtome and antioxidant

Debunking Seed Cycling as a Cure for PolyCystic Ovary Syndrome using Network Pharmacology

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Polycystic ovary Syndrome (PCOS) is one of the most prevalent endocrine disorders affecting women of reproductive age, with wide-ranging consequences on fertility, metabolism, and quality of life. While pharmacological and lifestyle interventions remain the mainstay of management, there has been a growing public shift toward natural and dietary strategies. One such practice, seed cycling, the sequential intake of flax, pumpkin, sesame, and sunflower seeds, has emerged as a popular self-care approach for hormonal balance. Notably, Google Trends analysis demonstrates a marked rise in global interest in seed cycling, highlighting its widespread acceptance despite limited scientific validation.

To bridge this gap, we employed a network pharmacology framework to decode the molecular basis of seed cycling in PCOS management. Bioactive phytochemicals from seed-cycling seeds were curated and mapped to potential protein targets using ligand-based and database-driven prediction tools. Protein–protein interaction (PPI) networks, pathway enrichment, and disease-association analyses were conducted to delineate therapeutic mechanisms. Our results indicate that seed-derived phytochemicals target key regulators of androgen biosynthesis, insulin resistance, inflammatory signaling, and ovarian folliculogenesis, pathways central to PCOS pathophysiology.

This integrative study combines computational pharmacology with digital epidemiology, providing mechanistic insights into the putative benefits of seed cycling and offering a scientific basis for its increasing popularity. By uniting traditional practices with modern systems biology, this work sets the stage for translational studies and clinical validation of seed cycling as a complementary strategy in PCOS management.

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Integrative Protein-protein Interaction Analysis of Polyhydroxyalkanoates Production: *Cupriavidus necator* as a Paradigm

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The pervasive accumulation and long-term persistence of single-use plastics have become an escalating environmental burden with the growing population and its increasing consumption needs. The possibilities of utilising agricultural waste such as lignocellulosic residues, crop stubble, fruit peels, and agro-industrial by-products have driven global interest toward the production of sustainable alternatives to synthetic plastics, such as bioplastics. Polyhydroxyalkanoates (PHAs) are a kind of bioplastics produced by diverse bacterial species as intracellular carbon and energy storage polymers under nutrient-limited conditions. Owing to their structural and mechanical similarities to petrochemical-derived plastics, PHAs have emerged as promising biodegradable and eco-friendly alternatives. The biosynthesis and intracellular accumulation of PHAs are regulated by a coordinated network of proteins, including 3-ketothiolases, acetoacetyl-CoA reductases, PHA synthases, phasins, and transcriptional regulators. These proteins interact within complex networks rather than acting independently, highlighting the importance of understanding protein–protein interactions (PPIs) to elucidate the regulatory mechanisms governing PHA metabolism. A deeper insight into these interactions is essential for rational strain engineering aimed at enhancing PHA yield and overcoming challenges in large-scale production and commercialization. In this study, we utilized the STRING database to construct and analyze the PPI network associated with PHA biosynthesis in *Cupriavidus necator*, one of the most extensively studied PHA-producing bacteria. Additionally, comprehensive data mining across multiple databases was performed to retrieve functional and structural attributes of the proteins involved. This integrative approach provides a foundational framework for future metabolic engineering strategies to optimize PHA production.

Nature derived 3D Bioprinted Patch for Diabetic Wound Healing applications

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Diabetic wounds, especially diabetic foot ulcers, affect millions of people worldwide. About 500 million people are affected by Diabetes mellitus worldwide, about 19-34 percent of these patients are affected with Diabetic foot ulcer (DFU). The DFU adversely affects the life quality of patients, leading to further complications such as amputation and even death[1]. The DFU also causes large financial burdens on the individuals. The current treatment methods are either non-patient compliant or not effective. Therefore, there is a need to develop new therapies and improve existing treatments to facilitate faster healing of diabetic wounds and avoid further complications caused by diabetic wounds.

Nature-derived biomaterials are attracting significant applications nowadays. Biomaterials and medicinal plants are used widely in the medical field. These materials are biocompatible, biodegradable, and contain bioactive components. Wound dressing is improving rapidly for quick, effective, scar-free healing of wounds. The 3D bioprinting method is a cutting-edge technology that helps in tailoring personalized treatment products.

This presents a detailed plan for identifying, validating, and developing a formulation that contains the healing power of medicinal plants, biomaterials to produce a 3D printed patch for diabetic wound healing applications. The study includes scientific analysis, bioink development, characterization, efficacy testing, and safety evaluation. The proposed study will significantly contribute to DFU treatment, leading to rapid wound healing, and a bioink with tunable properties that can be used for various applications.

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Phytochemical Characterizations and Functional Comparison of Grape Leaf Extracts with Resveratrol for Antioxidant and Anticancer Activities in *HeLa* cells

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Vitis vinifera (Red Globe variety) is widely cultivated for its large, sweet berries; however, its leaves remain an underutilized source of bioactive phytochemicals. These leaves are known to contain polyphenolic compounds, including resveratrol, a potent antioxidant and anticancer agent. This study focuses on the extraction and characterizations of phytochemicals from Red Globe grape leaves and their biological efficacy compared to pure resveratrol.

Ethanolic and methanolic extracts of Red Globe grape (*Vitis vinifera*) leaves will be compared in this study to evaluate their anticancer potential. The extracts will undergo qualitative and quantitative phytochemical analysis, and FTIR spectroscopy will be employed to identify functional groups associated with bioactive compounds. The antioxidant potential will be assessed using the DPPH radical scavenging assay, enabling a comparative evaluation of the antioxidant profiles of ethanol- and methanol-based extracts.

To determine anticancer efficacy, in vitro studies will be conducted on *HeLa* cervical cancer cells. The MTT assay will assess dose-dependent cytotoxicity to establish optimal extract concentrations. Cell viability analysis (DAPI staining) and scratch wound healing assay will be performed to examine the morphological changes and inhibition of cell migration. Finally, a comparative analysis will be done between the ethanolic and methanolic extracts with pure resveratrol to explore the potential additive or synergistic effects of crude phytochemical cocktail. Preliminary findings are expected to validate Red Globe grape leaf extract as a rich source of natural antioxidants with promising anticancer potential. This research underscores the value of agricultural by-products and supports the potential development of cost-effective, plant-based therapeutics.

Keywords: *Vitis vinifera* (Grape Leaf Extract), Resveratrol, Cervical cancer (HeLa), DPPH Assay, MTT Cytotoxicity

Can Poor Sleep Quality During Late Pregnancy Affect the Early Cry Features in Human Newborns? Evaluation Through AI & ML Tools

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Introduction: Maternal sleep loss during pregnancy affects the ultrasonic vocalization patterns in pups as evident from our pre-clinical studies done in rats (1,2). Recent report on human showed association of prenatal sleep with neonatal temperament (3). Present study was conducted to evualuate changes in cry signal of human neonates born to mother with normal and poor sleep quality during late pregnancy using AI and ML tools.

Methodology: After taking IEC approval from the Institute, pregnant mothers were recruited for this study and their questionnaire based sleep health index (SHI) was assessed during last trimester. At time of birth, 15 sec continuous cries of babies (1st CRY, vaccination, hunger and spontaneous) were recorded from a Hospital in Thycaud using H5-Zoom microphones. These signals were processed using librosa and parselmouth platforms to extract 23 acoustic features. After preprocessing, K mean classifer was used for preliminary clustering of cries. Further, hybrid CNN with attention and LSTM network were used for classification of Vaccine and Hunger cries.

Results: K mean algorithm clustered two distinct group of cries. In first group, where majority of cries were from mother's with low quality (SHI scores<70) displayed significantly higher F0, F median, hnr, and MFCC components 3,7,12 compared to the second group with higher sleep quality (SHI score>70) where other acoustic features were dominant including spectral centroid, weiner entropy, MFCC (1,2,4,5,6,8,11,13), pitch IQR, jiter and shimmer. For classification of vaccine and hunger cry types, the hybrid CNN network showed 90% accuracy in the model.

Conclusions: This is first study to report effects of sleep loss during pregnancy on development of baby's cries pattern for an early detetion of anomalies.

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Intrinsic Conformational Transitions in Immunoregulatory Human Cathepsin S and its Modulation by Adapalene

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Cathepsin S (CatS), a lysosomal cysteine protease involved in antigen presentation and extracellular proteolysis, is a therapeutic target in autoimmune and inflammatory diseases. Its ligand-binding site exhibits significant plasticity, and the mechanisms driving its dynamic conformational transitions remain incompletely understood. This structural flexibility can significantly influence inhibitor selectivity.

Objectives: To characterize CatS conformational transitions and assess how the FDA-approved drug adapalene modulates the active-site gating mechanism and inhibits CatS.

Methods: Apo and adapalene-bound CatS-systems were simulated (500 ns each) using GROMACS. Initial binding poses were obtained by docking. Conformational changes of Phe 211, Phe 70, and Tyr118 were analyzed through dihedral angle monitoring, distance measurements, and visualization of open/closed gating states. A comparative analysis was conducted between bound and unbound systems to assess ligand-induced effects.

Results: Coordinated side-chain rotations of Phe211, Phe70, and Tyr118, combined with inter-residue interactions, result in open, closed, and three dynamic semi-closed states contributing to the plasticity of the S2 binding pocket of CatS. Adapalene binding sterically hindered the Phe70/Phe211 motion, reducing closure frequency and stabilizing ligand-accommodating states.

Conclusion: The cooperative gating mechanism of Phe211, Phe70, and Tyr118 modulates active site flexibility and ligand accommodation in CatS. This offers structural insights for the design of conformation-specific CatS inhibitors targeting autoimmune and inflammatory diseases.

Long non-coding RNAs Regulating TLR4 Signaling as Therapeutic Targets for Cardiac Fibrosis

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During cardiac injury, cardiac fibroblasts (CFs) become activated and secrete excess extracellular matrix (ECM), which compensates for the loss of cardiomyocytes and contributes to fibrosis. Chronic fibrotic remodeling negatively affects cardiac function leading to heart failure. The immune signaling activated by inflammation in the injury area influences this fibrotic remodeling. Following cardiac injury, TLR4 signaling is activated in both adult human and mouse CFs. Inhibition of TLR4 using TAK-242, a small molecule inhibitor, reduced expression of fibrotic genes alpha-SMA and Collagen1A1(COL1A1) to 0.7+/- 0.86 and 0.78+/-0.02 ($p<0.05$) fold respectively, in-vitro. In a scratch wound assay, TLR4-inhibited CFs exhibited an 80% ± 0.4% ($p < 0.05$) reduction in cell migration. Furthermore, CFs showed diminished contractility induced by TGF-β, with an increased gel area of 92.82 ± 1.39% ($p > 0.05$) when treated with TAK-242. These findings indicate that TLR4 inhibition reduces fibrotic changes in adult CFs in-vitro (1). To understand the molecular mechanism and identify possible RNA-based therapeutic targets, we examined the non coding RNA landscape in TGF-β induced CFs with and without TAK-242. Transcriptomics data revealed 18.8% of differentially expressed transcripts as lncRNAs. Notably, LINC00578 was upregulated upon TGF-β induction and showed a strong co-expression with the fibrotic genes, COL8A1, TGFBR1and GDF6 (pearson correlation >0.9). In addition, TAK-242 treatment downregulated LINC00578 along with TLR4 pathway genes MAPK8, MYD88 and MAPK14 suggesting a possible regulatory role of LINC00578 in TLR4 mediated fibrotic remodeling. Ongoing experiments are looking at the interaction of LINC00578 with TLR4 pathway genes. The mechanistic role of LINC00578 in cardiac fibrosis is also being studied using LINC00578 knocked out cells. Our study would contribute towards developing lncRNA based therapeutic targets for cardiac fibrosis.

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Atrogin-1/Myocardin Axis as a Developmental Switch for Chicken Smooth Muscle Maturation and Cultured Meat Engineering

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The efficient production of cultured meat is currently limited by the slow and incomplete maturation of muscle cells into functional tissue. Our laboratory aims to overcome this bottleneck by identifying molecular switches that accelerate this process. We investigated the E3 ubiquitin ligase Atrogin-1 in a chicken smooth muscle model, using both in vivo developmental stages (comparing undifferentiated embryonic day 4 [E4] and differentiated E15 gizzards) and an in vitro culture system where differentiation was maintained with Insulin-like Growth Factor-1 and proliferation was induced with Fetal Bovine Serum.

Contrary to its muscle-wasting role in skeletal muscle, our research revealed that Atrogin-1 is a potent promoter of maturation. Reverse Transcription-PCR and immunofluorescence showed that Atrogin-1 expression and distinct perinuclear localization are hallmarks of the mature state in both models. To test its function directly, we overexpressed Atrogin-1, which significantly increased mRNA levels of the master regulator Myocardin and elevated protein levels of the contractile marker Calponin-1. This provides a clear molecular mechanism by which Atrogin-1 drives cells toward a mature phenotype.

Our results identify the Atrogin-1/Myocardin pathway as the pro-maturation switch we were seeking. We conclude that engineering this axis is a promising strategy to overcome the maturation bottleneck in cellular agriculture. Our ongoing work focuses on leveraging this mechanism to improve maturation efficiency and tissue architecture in smooth muscle cells for next-generation cultured meat systems.

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Therapeutic *Aegle marmelos*-Loaded 3D printed Collagen Mat for Wound Healing

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Chronic wounds present significant clinical challenges due to infection risks, prolonged healing times, and limited efficacy of conventional dressings. This study aims to develop a biocompatible and sustainable 3D-printed wound dressing by integrating marine-derived collagen from *Lutjanus argentimaculatus* (red snapper) skin with phytochemicals extracted from *Aegle marmelos* leaves. The fish marine collagen, rich in type I collagen, was isolated and characterized using FTIR and ICP-MS, confirming its purity and safety. The bioactive phytochemicals were extracted via maceration and characterized using FTIR and LC-MS, identifying compounds with proven antioxidant, antibacterial, and wound healing properties. Collagen-alginate (1:4) biomaterial ink was optimized for 3D printing to fabricate scaffolds with and without phytochemicals. *In vitro* studies using L929 mouse fibroblasts and hADMSCs demonstrated enhanced cytocompatibility, cell proliferation, and wound closure with phytochemical-loaded scaffolds. SEM imaging revealed improved cell attachment and extracellular matrix deposition. Additional assays confirmed the scaffold's biodegradability, swelling ability, and sustained phytochemical release, supporting its functional performance as a wound dressing.

The innovation in combining phytochemicals with scaffolds in regenerative medicine lies in the synergistic integration of natural bioactivity with engineered biomaterials to promote tissue repair more effectively, safely, and sustainably. The fabricated scaffold exhibits significant promise for personalized wound care, aligning with global sustainable development goals (SDGs 3, 9, and 12). The study provides a foundation for future translational research in regenerative medicine and advanced wound care.

Keywords: 3D Bioprinting**,** Marine Collagen**,** *Aegle marmelos***,** Phytochemical-loaded Scaffold, Wound Healing

Structural and Functional In-Silico Analysis of ERG3 Targeting in *Candida albicans* Antifungal Therapy

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Alterations in the ERG3 gene, encoding sterol C-5 desaturase, which plays a critical role in ergosterol biosynthesis and membrane integrity in *Candida albicans*, have been closely linked to resistance against widely used antifungal agents, including azoles and polyenes. This study deployed a comprehensive computational workflow encompassing protein structure modeling, molecular docking, mutational analysis, and molecular dynamics simulations to unravel ERG3-mediated drug resistance mechanisms. The C. albicans ERG3 sequence was retrieved from UniProt and modeled using AlphaFold/SWISS-MODEL. Representative antifungals, fluconazole and amphotericin B, were docked to the predicted binding pockets using AutoDock Vina (PyRx), revealing interacting residues and binding affinities. In silico mutagenesis generated loss-of-function and pocket-site point mutants that were re-docked to assess changes in drug binding. Brief MD simulations (10–50ns) evaluated complex stability and interaction dynamics. The results indicate that specific ERG3 mutations alter drug-binding energetics and protein-ligand stability, supporting mechanistic models for azole and polyene resistance. This approach provides a rapid, cost-effective platform for prioritizing mutations relevant to therapy, and guides follow-up experimental validation and rational design of new antifungal strategies.

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Effect of Septin 11 on Adipocyte Differentiation and Hypertrophy

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Obesity, a global health issue of increasing concern, is characterized by excessive fat accumulation. It involves adipose tissue growth and this expansion of adipose tissue occurs through two main processes: adipocyte hyperplasia and adipocyte hypertrophy. Hyperplasia involves the formation of new adipocytes from precursor cells, while hypertrophy refers to the enlargement of existing adipocytes due to more lipids.Although adipocyte hypertrophy is central to obesity, the molecular mechanisms behind the structural changes in adipocytes during this process are not fully understood (1).

Cytoskeleton reorganization occurring in hypertrophic adipocytes should occur in accordance with the expansion of lipid droplets. We hypothesized that septins mediates the crosstalk between lipid droplet and cytoskeleton reorganization and this aspect remains insufficiently explored. Septins are a highly conserved family of GTP-binding proteins, now recognised as the fourth component of the cytoskeleton, alongside actin filaments, microtubules, and intermediate filaments(2). One member of the Septin family, Septin 11 (SEPT11) was shown to be upregulated in adipocytes during obesity and crucial for lipid droplet biogenesis from the endoplasmic reticulum. However, septins are the least studied cytoskeletal type in eukaryotic cells and the functional relevance of septins in adipocytes has not yet been completely deciphered. The present study investigated the role of Septin 11 in adipocyte differentiation and on the expansion of lipid droplets under hypertrophic conditions.

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Comparative Evaluation of Osteogenic Induction Potential of Magnesium Phosphate Cement and Genistein using Adipose-Derived Mesenchymal Stem Cells

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Osteoporotic bone defects pose a significant challenge in clinical orthopedics due to impaired bone regeneration and reduced osteogenic signaling. The current study explores the osteoinductive potential of magnesium phosphate cement (MPC) and phytoestrogen genistein, aiming to establish their efficacy in promoting osteogenic differentiation *in vitro*. This preliminary investigation serves as a foundational step for developing a genistein-incorporated MPC scaffold for the treatment of osteoporotic bone defects.

The study will involve the characterizations of MPC powder and genistein, which will be performed using FTIR and SEM to assess structural and compositional properties. Rat adipose-derived mesenchymal stem cells (rAD-MSCs) will be used for all *in vitro* assays. Cell viability and cytotoxicity will be determined via MTT assay and live/dead staining, followed by dose optimization. Osteogenic differentiation will be evaluated at 14 and 28 days using Alizarin Red S staining and alkaline phosphatase (ALP) activity as markers of mineralization and early osteogenesis.

Preliminary results are expected to elucidate the individual osteoinductive capabilities of genistein and MPC, thereby guiding the design of a synergistic composite scaffold. This study sets the groundwork for future research targeting the development of a phytochemical-functionalized bone graft substitute for effective osteoporotic bone repair.

Keywords: Osteogenesis, Magnesium Phosphate Cement, Genistein, Adipose-Derived Mesenchymal Stem Cells, Bone Tissue Engineering

Phytochemical Loaded Electrospun Composite Scaffold for Skeletal Regeneration

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Bone and cartilage injuries (from trauma, degeneration, or disease) are common and notoriously hard to heal. Large bone defects often outpace the body's repair capacity, and articular cartilage has an inherently limited ability to self-repair. Traditional treatments like autografts or metallic implants have serious drawbacks (donor-site morbidity, risk of rejection, stress shielding, wear debris, etc.) and frequently fail to integrate long-term. In short, there is a strong clinical demand for new grafts that are bioactive, biocompatible, and able to genuinely stimulate bone/cartilage regeneration.

As a solution, researchers are developing biodegradable polymer scaffolds that mimic the native extracellular matrix (ECM) and are loaded with plant-derived bioactive molecules. Electrospinning produces nanofiber mats with high porosity and tunable mechanics, ideal for cell attachment. When natural phytochemicals (e.g. polyphenols or herbal extracts) are incorporated, the resulting scaffold can provide antioxidant/anti-inflammatory cues and promote bone-forming signals

These scaffolds, enriched with plant-derived compounds such as polyphenols, curcumin, icariin, and *Cissus quadrangularis* extract, have demonstrated improved cell attachment, proliferation, osteogenic differentiation, and angiogenesis in various in vitro and in vivo models. As more in vivo and clinical studies emerge, phytochemical-enriched scaffolds could become powerful next-generation implants for healing complex bone and cartilage defects.

This poster reviews recent progress in phytochemical-loaded electrospun scaffolds. It explores how plant-derived compounds boost the regenerative ability of biomaterials.

Keywords: Bone regeneration, electrospinning, phytochemicals, nanofibers, osteogenesis, biomaterials.

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Integrative Bioinformatics Identification of Prognostic Biomarkers Associated with Ischemic Stroke and Its Major Risk Factors

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Ischemic stroke (IS) is a complex, multifactorial cerebrovascular disorder driven by intersecting pathophysiological mechanisms and modifiable risk factors such as diabetes mellitus, smoking, obesity, hypertension, and atrial fibrillation. This study employs a systems-level bioinformatics framework to delineate key prognostic biomarkers that are transcriptionally dysregulated in IS and its risk milieu. Publicly available transcriptomic datasets were retrieved from the Gene Expression Omnibus (GEO), and differentially expressed genes (DEGs) were identified using R-based pipelines incorporating thresholds for adjusted p-values and log2 fold change. Gene annotation consistency was ensured using standardized HGNC identifiers.

To augment dataset-derived findings, gene associations were integrated from curated databases including MalaCards, GeneCards, DisGeNET, and OpenTargets. A Venn diagram intersection approach was employed to identify genes with shared dysregulation patterns across IS and its comorbid conditions. Functional networks were constructed using Cytoscape, focusing on high-confidence protein–protein interactions (PPIs). Gene ontology (GO) and Kyoto Encyclopedia of Genes and Genomes (KEGG) enrichment analyses were conducted to elucidate implicated biological processes and signalling pathways.

Validation was conducted via receiver operating characteristic (ROC) curve analyses using the GSE16561 dataset to assess the diagnostic potential of candidate genes. IL1B, MMP9, PTGS2, ADM, and PDE5A emerged as consistently upregulated and exhibited high discriminatory power, with established roles in neuroinflammation, endothelial dysfunction, oxidative stress, and coagulation cascades—central processes in IS pathogenesis.

Our findings propose these genes as robust prognostic biomarkers and potential therapeutic targets for ischemic stroke, particularly in the context of its systemic risk profile. The integration of transcriptomic and disease-association data provides a scalable model for biomarker discovery in complex neurological disorders.

Evaluation of the Chemotherapeutic Efficacy of 7β-acetoxy-6β-Hydroxyroyleanone (AHR) against Colorectal Cancer

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Bioactive compounds derived from natural sources have been widely explored for therapeutic applications. Royleanone, a diterpene present in the Plectranthus species, has been reported to possess antimicrobial and antiproliferative properties (Ndjoubi et al., 2021). This study has investigated the chemotherapeutic potential of 7β-acetoxy-6β-hydroxyroyleanone (AHR) against colorectal cancer (CRC). Anticancer potential of AHR was analysed in cancer cell lines of different tissue origins by MTT assay. HCT116, the CRC cell line emerged as the most sensitive to AHR and the efficacy of AHR against other CRC cell lines was confirmed by MTT assay. Cytotoxic mechanism of AHR in HCT116 was determined as Apoptotic cell death by FACS analysis. Immunoblot analysis was used to delineate the apoptotic pathway in HCT116 cells and the results revealed involvement of both the extrinsic and intrinsic pathway. Molecular investigations into the anticancer activity of AHR in HCT116 cells by immunoblot and Q-PCR analysis, revealed that AHR activates apoptotic pathway via tumor suppressor protein 53 (p53) and inhibits the anti-apoptotic pathway by regulating phosphatidylinositol 3-kinase (PI3K) signaling. Further, the combinatorial effect of AHR with the chemo preventive, Curcumin was evaluated and a synergistic effect was observed by MTT assay. The efficacy of the combination was confirmed by Acridine orange -Ethidium bromide fluorescent staining assay and apoptosis was evaluated by immunoblot analysis of PARP cleavage. The results demonstrate the potent chemotherapeutic efficacy of AHR with an apoptotic mode of cell death against CRC. The compound is worth further exploration as a novel anticancer agent against CRC either alone or in combination with other anticancer agents.

An Insilico Investigation of the Mir-195/497 Cluster Network in Breast Cancer: Pathway and Prognostic Analysis

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Breast cancer is one of the most common types of cancer, prevalent particularly in women. Several research studies have identified microRNA as a potential biomarker for cancer. The miR195 and miR497 are known for their roles in several types of cancer **[1] [2].** However, this study is a comprehensive analysis of the miR-195/497 cluster in breast cancer, conducted using publicly available databases. The in silico analysis and validation were conducted using tools like miRBase, TCGA-UALCAN, EVmiRNA, miRNet, STRINGv.11, Cytoscape, Cytohubba, TIMER 2.0, WebGestalt, KEGG Database, GEPIA 2, Cancer Hallmark Tool, and PanDrug 2. Our objectives were 1. To study the deregulated expression and the differentially expressed target genes of this cluster in breast cancer, 2. To construct the miR-target gene network, PPIN, and to identify the hub genes, the immune infiltration analysis, and gene ontology-based functional enrichment analysis, 3. To determine prognostically significant and cancer hallmark genes, and to investigate the drug-target interaction. The results revealed a significant downregulation of the miR-195/497 cluster in breast cancer samples (142) compared to normal samples (76) and identified 250 differentially expressed gene targets. The prognostically significant genes out of the DEGs were found to be UNC5B, EPB41L4B, EDA, PPM1L, SLC12A2, PSKH1, ADAMTSL3, DDX3X, CHEK1, BACH2, SH2D2A, and PAFAH1B1. The hallmark gene analysis led to the recognition of 19 genes involved in tissue invasion and metastasis. An investigation of interactions between drugs and genes showed 20 FDA-approved drugs for cancer treatment. This study highlights the miR-195/497 cluster's role in breast cancer and its potential as a biomarker, emphasising the need for further validation.

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Plastic Degradation by Extremophiles in Acid Mine Drainage sites

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Acid mine drainage (AMD) sites represent extreme acidic ecosystems where low pH, high metal content, and unique microbial communities coexist. Among these microbes, Acidothiobacillus ferrooxidans, an acidophilic chemolithotroph, has attracted attention for its ability to survive and metabolize under such harsh conditions. Recent studies have explored the potential of A. ferrooxidans strains, isolated directly from AMD environments, in contributing to the degradation of synthetic plastics that are often discarded at or transported into these sites. In experimental setups, plastic pieces such as polyethylene and polypropylene were introduced into culture media inoculated with the isolated bacterium. Over the course of incubation, morphological changes on the plastic surface were observed using stereo microscopy, revealing pitting, surface roughness, and biofilm formation. Complementary analysis using Fourier Transform Infrared (FTIR) spectroscopy demonstrated significant alterations in functional groups, particularly in C–H stretching and carbonyl peaks, indicating oxidative modification of polymer chains. These findings suggest that the combination of acidic conditions and microbial activity accelerates early stages of plastic degradation. Thus, AMD-derived A. ferrooxidans serves as a model for understanding plastic biodegradation in extreme acidic environments, with implications for both environmental remediation and the development of novel bio-based recycling strategies

In-silico and I*n-vitro* Evaluation of Docetaxel and Berberine as potential p53 modulating Apoptotic inducers in Oral Squamous Cell Carcinoma

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Objective: To investigate the interaction of p53 with docetaxel and berberine and their anticancer activities against oral squamous cell carcinoma.

Methods: The interaction between p53 with docetaxel and berberine was investigated and their mechanisms of action against oral squamous cell carcinoma were studied. Toxicity studies were performed to determine any toxic impact of the drugs on the vital organs of tested animals.

Results: *In silico* results revealed the molecular interaction of docetaxel and berberine with p53 and the molecules were found to be potential p53 inducers. Docetaxel and berberine inhibited the proliferation of cancer cells in a concentration-dependent manner. Flow cytometry analysis revealed that docetaxel and berberine at IC50 concentrations upregulated the expression of p53 in oral squamous cell carcinoma cells, thus triggering apoptotic cell death. In addition, no toxicity was observed in the liver and kidney tissues of mice after docetaxel and berberine treatment.

Conclusions: Docetaxel and berberine significantly suppressed the proliferation of oral cancer cells by activating p53 expression and causing apoptotic cell death. Both compounds can be potential agents for the treatment of oral cancer, with little to no toxicity at the tissue level.

Keywords: Docetaxel; Berberine; p53; Anticancer; Apoptosis.

Donor Specific Cell free DNA and Exosomes: Upcoming Biomarkers for Male-to- Female Renal Transplantation Rejection

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In renal transplantation, exosomes and donor-specific circulating cell-free DNA are two promising indicators for identifying and tracking graft rejection. Exosomes are tiny vesicles that contain DNA, lipids, proteins, RNA, MiRNAs and noncoding RNAs; they may functionally communicate between cells with high potential as non-invasive biomarkers in renal transplant patients. Male-to-female (Husband to wife) transplantation is a convenient way of transplantation, based on social and ethical considerations. In the present study, a total of 10 patients were monitored for cfDNA within different time intervals. A Y chromosome-specific DYS14 primer was used to evaluate donor-derived cfDNA (Dd-cfDNA) in male-to-female kidney transplantation. The same patients were monitored for their urinary exosome protein and total RNA levels. Exosomes are characterized by Immunoblotting and microscopic methods. Rejection-specific miRNA (miR326) from urinary exosomes could be characterized by using a miR326 primer designed in our lab. Conventional statistical measures of significance value were found to be analyzed. According to our findings, transplant patients had higher levels of total CfDNA (108.5µg/ml), urine exosome miRNA (585.5µg/ml), and protein (46.75µg/ml) than healthy individuals. The quantity of Cf-DNA correlated with serum creatinine level (r=0.36; P value=0.01), which is generally used as a rejection marker. The study also found to correlate Quantity of Cf-DNA with Tacrolimus level (r=0.57; P value=0.00) in patients, also indicating the rejection process. The amount of Cf-DNA is high on day 30 compared to day 4 and day 14. It indicates that the high level of Cf-DNA release is due to active rejection of the transplanted organ. The preparation of exosomes, characterised by FE-SEM and TEM analysis, showed a spherical or cup-shaped morphological appearance with an average size of 56.4 nanometers were observed. To confirm the presence of exosome surface markers, CD63 and the control β-actin were also analysed in Western blot analysis.

Keywords: Transplantation, dd-cfDNA, Vesicles, Chromosome Y, Immunoblotting

Evaluating Foot and Mouth Disease Management Strategies in India using Agent-Based SEIRC and SEIRC-V Models

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Effective disease management is essential for reducing the impact of Foot-and-Mouth Disease (FMD) in India, where high livestock density, cross-border animal movement, and socio-cultural constraints against culling complicate control efforts. Simulation models, particularly agent-based approaches, are valuable decision support tools for comparing outbreak scenarios and assessing intervention strategies. Vaccination, long proven effective against infectious diseases, remains a central but debated component in FMD control policy.

In this study, we used an agent-based SEIRC (Susceptible–Exposed–Infectious–Recovered–Carrier) model and an extended SEIRC-V version incorporating vaccination to evaluate three strategies: (i) no vaccination (SEIRC), (ii) national prophylactic vaccination before an outbreak (SEIRC-V), and (iii) ring vaccination during an epidemic (SEIRC-V). Three FMDV serotypes (O, A, and Asia 1) are currently circulating in India, with recent campaigns achieving protective titers of 82.3%, 76.7%, and 78.7%, respectively. Simulations tested 50% and 70% vaccine coverage under basic reproduction numbers (R_0) of 2, 4, and 8.

Prophylactic vaccination (SEIRC-V) consistently reduced outbreak size and duration across all R_0 values. Ring vaccination (SEIRC-V) reduced outbreak size but delayed epidemic onset, potentially prolonging disease presence. This work demonstrates the utility of agent-based SEIRC and SEIRC-V modeling in evaluating realistic, non-lethal FMD management options in endemic settings, integrating epidemiological dynamics, serotype-specific immunity, and operational constraints.

Keywords: Foot-and-Mouth Disease, Disease Management, Agent-Based Modeling, Prophylactic Vaccination, Ring Vaccination, India.

Development of a Cellulose-based Immunoprecipitation (cIP) Matrix for Cost effective Protein Purification

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Immunoprecipitation (IP) is one of the most common practices for protein purification and for the analysis of protein-protein interactions. Traditionally available protein A/G agarose beads are effective; however, they require refrigerated storage and are expensive, which limits their use in labs with limited resources. To overcome these limitations, we propose the development of a cost-effective, cellulose-based IP (cIP) matrix. Silanization facilitates the amine grafting of cellulose surface with 3-aminopropyltriethoxysilane (APTES), followed by glutaraldehyde crosslinking to enable stable covalent antibody immobilization. Our preliminary FTIR-based studies confirmed successful surface modification, while the immobilization of HRP-conjugated antibodies was estimated by TMB-based colorimetric assay. IP of target protein (EGFR) using corresponding antibody (cetuximab) was confirmed using cIP and western blotting analysis. The proposed cIP matrix efficiently immunoprecipitated the target protein (EGFR) from mammalian cell lysates, exhibiting high specificity, stability, and reusability over multiple cycles, with performance comparable to that of commercial Protein A/G beads.

Keywords: Immunoprecipitation, Cellulose Matrix, Protein Purification, FTIR, Antibody

Deciphering the role of a MYB transcription factor in Powdery Mildew resistance in *Medicago truncatula*

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Powdery mildew (PM) fungi infect many plant species, including legumes, causing yield losses of 25-50%. Resistance sources against PM, specifically *Erysiphe pisi*, have been identified in *Medicago truncatula*. Recent studies revealed a multi-layered defense involving the phenylpropanoid pathway and defense phytohormones in a resistant *M. truncatula* genotype. Transcription factors (TFs), such as MYBs, regulate these defense pathways, including the synthesis of secondary metabolites during pathogen infection. RNA-Seq analysis identified a MYB TF significantly induced in the resistant genotype. Here, we investigate whether this MYB TF provides resistance against PM. In transient overexpression assays, the MYB TF was found to localize the nucleus and induce the expression of isoflavonoid biosynthesis genes in a moderately susceptible *M. truncatula* genotype. Quantitative analysis using RT-qPCR and LC-MS confirmed the role of gatekeeper genes and metabolites in PM resistance. These findings could offer novel targets for managing PM disease in legumes.

Keywords: Powdery mildew, *Medicago truncatula*, MYB, RNA-Seq

Deciphering the Survival Strategies of *Klebsiella pneumoniae* through Inflammasome Activation and Autophagy Inhibition

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Klebsiella pneumoniae (KP), has emerged as a significant pathogen in healthcare settings, contributing to severe infections including pneumonia, bloodstream infections, urinary tract infections particularly affecting immunocompromised individuals. Given the rising concern of antimicrobial resistance (AMR), deciphering the mechanism behind its survival strategies within the host is a need of the moment. This study investigates how different strains of *Klebsiella pneumoniae* including classical, hypervirulent (HVKP), and multidrug-resistant (MDR) variants employ distinct strategies to modulate host immune pathways to promote intracellular survival. Lactate Dehydrogenase Assay (LDH) was used to determine the strain dependent cytotoxicity upon its infection on THP1- derived macrophages. Inhibition of the NLRP3 inflammasome with a potent inhibitor significantly reduced MDR bacterial survival, indicating that inflammasome activation supports immune evasion, particularly in drug-resistant strains. Quantitative real time PCR (qRT-PCR) and Western blot analysis confirmed inflammasome activation, which revealed enhanced NLRP3 and Gasdermin D expression and cleavage in MDR and HVKP infections. The functional significance of NLRP3 signaling in the survival of pathogen was further supported by the significantly higher expression of *IL1β* in cells infected with KP compared to uninfected controls and the subsequent reduction when treated with the inhibitor. In accordance with that the autophagy genes were observed to have reduced levels of expression upon these infections. Additionally, confocal imaging validated the reduced expression levels of autophagy-related genes and upregulated levels of inflammasome components in infected THP-1 derived macrophages. Overall, these findings suggest that KP employs strain-specific immune evasion strategies by relying on inflammasome activation and autophagy suppression. These results highlight the importance of developing targeted interventions to combat AMR and effectively manage infections caused by this resilient bacterium.

Phytochemical and Biological Assessment of rhizome extract of *Drynaria quercifolia*: Insights into - Antioxidant, Antibacterial, Fibroblast-driven wound healing potential

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Natural products derived from medicinal plants have long served as therapeutic agents in wound healing due to their non-cytotoxicity, antioxidant, and antimicrobial properties. *Drynaria quercifolia*, a traditionally used fern specie, is rich in polyphenolic compounds and is believed to possess wound-healing potential. This study aims to investigate and compare the antioxidant, antibacterial, and fibroblast-mediated wound healing properties of methanol and ethanol extracts of *D. quercifolia*.

The dried rhizomes of *D. quercifolia* will be extracted using methanol and ethanol solvents. Phytochemical characterizations will include quantification of total phenolic content (TPC) and total flavonoid content (TFC), and Fourier-transform infrared spectroscopy (FTIR) will be used to identify key functional groups. Antioxidant potential will be assessed using DPPH radical scavenging assays. The antibacterial efficacy of the extracts will be evaluated against common wound pathogens using the disc diffusion method.

For biological validation, *in vitro* studies will be performed using L929 mouse fibroblast cells. Non-cytotoxicity will be assessed through MTT assay, while DAPI staining will be performed to observe nuclear integrity and detect potential apoptotic changes, if any. Simultaneously, a scratch wound assay will be done to assess fibroblast migration and simulate wound healing under laboratory conditions.

It is anticipated that both extracts will exhibit measurable antioxidant and antibacterial activity, with the methanolic extract potentially showing greater efficacy due to higher phenolic and flavonoid content. *In vitro* assays are expected to demonstrate the non-cytotoxicity of the extracts, with enhanced fibroblast migration and proliferation observed particularly in the methanol-treated group.

The proposed comparative study is expected to validate the wound healing potential of *D. quercifolia* extracts, laying the groundwork for their incorporation into biocompatible wound dressings or hydrogel-based delivery systems in perspective of *in vivo* investigations for clinical applicability.

Evaluation of the Anti-inflammatory and Angiogenic Effects of Curcumin on Mesenchymal Stem cells for Wound Healing Applications

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Wound healing is a natural physiological reaction to tissue injury. However, it is complex and involves a complicated interplay between numerous cell types, cytokines, mediators, and the vascular system.[1] Despite its complex mechanism, approximately 60 million people worldwide are being treated for chronic and nonhealing wounds.[2] Recent wound healing strategies focus on stem cell based regenerative therapies and nanocarrier delivery systems.[3] MSCs are one of the major cell types used in regenerative medicine.[4]

MSCs regulate immune response and inflammation and possess powerful tissue reparative mechanisms, making these cells attractive for treatment of different diseases. Specifically, they have been successfully used to treat chronic wounds and stimulate stalled healing processes.[5] Stem cell migration which is an essential during the healing of skin wounds are activated by specific niches, especially via using the genetic modifications and through the use of biochemical cocktails.[6] Advanced biomaterial approaches are also used which including hydrogels, bioengineered skin grafts, and 3D-bioprinted constructs that accelerate tissue regeneration.[3]

Traditional therapies use plant-derived compounds like curcumin, neem, and honey to accelerate wound healing by modulating inflammation, preventing infection, and stimulating tissue regeneration. Curcumin, a hydrophobic polyphenol derived from turmeric (*Curcuma longa*), possesses potential antioxidant, anti-inflammatory and anti-tumorigenic traits.[7] It reduces pro-inflammatory cytokines such as TNF-α and IL 1, balances reactive oxygen species (ROS) with antioxidant activity, and induces apoptosis in inflammatory cells.[8] Additionally, curcumin upregulated genes crucial for healing such as COL1, KGF-1, and EGFR, through ERK signalling pathways, contributing to enhanced collagen synthesis, fibroblast activity, and angiogenesis.[9] This research poster aims to determine the anti-inflammatory and angiogenic effects of curcumin on MSC with specificity to wound healing applications through gene expression studies.

Dental Benefits of Mango Leaves: Traditional Knowledge to Modern Applications

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Mango (*Mangifera indica*) is widely used in traditional medicine systems like Ayurveda and folk practices in Asia and Africa. While the fruit is well-known for its taste and medicinal properties, the leaves have been traditionally used for their health benefits, especially in oral and dental care. People have long chewed mango leaves or used them as a mouth rinse to treat problems like gum disease, toothaches, and bad breath. Modern research now supports these traditional uses, showing that mango leaves contain active compounds such as mangiferin, tannins, flavonoids (like tamarixetin), and phenolic acids. These natural substances have antimicrobial, anti-inflammatory, antioxidant, and anti-plaque properties, making mango leaves a valuable ingredient for oral health.

Studies in laboratories and on animals have confirmed that mango leaf extracts can stop the growth of harmful mouth bacteria like Streptococcus mutans and Porphyromonas gingivalis, which cause cavities and gum disease. Their anti- inflammatory action also helps reduce gum swelling and bleeding. This review poster connects traditional knowledge with modern science, highlighting the potential of mango leaves in natural dental products like mouthwashes, tooth powders, and bioactive dental coatings. Using mango leaves in oral care supports traditional practices for maintaining good dental hygiene.

Key words: *Mangifera indica*, tissue regeneration, dental diseases, antibacterial activity.

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ZnFe Layered Double Hydroxide Alginate-Based 3D Printed Scaffold for Enhanced Bone Regeneration

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Layered double hydroxides (LDHs) or anionic clays have garnered significant attention in biomedical applications due to their versatile chemical properties. In this study, ZnFe-LDH was mixed with alginate to fabricate 3D-printed scaffolds using extrusion-based method. The innovative Zn-Fe LDH alginate gel was meticulously developed and characterized, focusing on key properties such as water content, swelling ratio, mechanical properties, and rheological behaviour, with successful optimization for 3D printing capabilities to ensure accurate and reproducible scaffold fabrication. Furthermore, Fourier-transform infrared spectroscopy (FTIR), scanning electron microscopy (SEM), and energy-dispersive X-ray spectroscopy (EDX) analyses provided comprehensive insights into the chemical composition, surface morphology, and elemental distribution of both bare and BPC-157-loaded scaffolds.

The Confocal microscopic evaluation of cell growth on a 3D-printed Zn-Fe LDH alginate scaffold for 14 days was also performed. The 3D-printed Zn-Fe LDH alginate scaffold supported cell attachment, spreading, and proliferation, indicating high biocompatibility. Following implantation in a rabbit femur defect model, the scaffolds demonstrated their capacity to support a robust healing response. Notably, new bone formation was observed at the wound site, with woven bone detected at both 4- and 12- weeks post-implantation. The material exhibited osteogenic properties and high biocompatibility, showing no signs of inflammation, which is critical for successful tissue integration. Additionally, the presence of residual scaffold material indicated the degradability of the scaffolds, confirming their role in supporting bone remodeling processes over time. The newly developed ZnFe-LDH alginate scaffold is an advanced material for supporting osteogenic potential and enhanced regenerative outcomes achieved through the incorporation of the therapeutic peptide BPC-157. The porous, biodegradable nature of the scaffold enhanced cell migration, nutrient exchange, vascularisation, and mineralisation for new bone formation.

Key words: Layered double hydroxide, 3D printed scaffold, BPC-157, biocompatible, osteogenesis

Redox Modulation and Apoptosis as Mechanisms of Gastric Cancer Cell Inhibition by *Artemisia* Essential Oil

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Artemisia nilagirica, traditionally used in Ayurvedic medicine for inflammatory disorders and detoxification, was investigated for its anticancer activity against gastric carcinoma. Essential oil extracted from the plant was tested on AGS and KATO III cell lines. Gas Chromatography–Mass Spectrometry (GC–MS) identified α-thujone, germacrene-D, caryophyllene, and borneol as major constituents. The oil exhibited dose-dependent cytotoxicity, accompanied by reduced intracellular antioxidants, glutathione depletion, and increased thiobarbituric acid reactive substances (TBARS), indicating enhanced lipid peroxidation. Treatment induced cytochrome c release and activation of caspase-3 and caspase-7, confirming apoptosis. Reactive oxygen species (ROS) generation, quantified by DCFDA assay, increased in a dose-dependent manner, establishing oxidative stress as a central mechanism. Molecular docking further revealed strong binding of bioactive compounds with cancer-related targets. These findings demonstrate that *A. nilagirica* essential oil exerts potent anti-proliferative effects on gastric cancer cells through ROS-mediated apoptosis, supporting its potential as a natural therapeutic candidate.

Keywords: Gastric cancer; Apoptosis; Redox imbalance; Cytochrome c release; *Azima tetracantha*

Evaluation of Toxicity and Apoptotic Properties of *Aspergillus terreus* Ethyl Acetate Extract Using Zebrafish Embryo Model

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Aspergillus terreus is a ubiquitous fungus producing a variety of secondary metabolites that are economically significant. They have recently been shown to have bioactive potential. Zebrafish models have been used extensively to assess the toxicity of natural products or their derivatives. In the present study, an evaluation of the developmental and genotoxic nature of ethyl acetate extract (ATE) of the fungus, *A. terreus* was performed in zebrafish embryos. TheLC50 was obtained by calculating the embryo mortality rate after 24 hours of exposure to various concentrations of the extract. Four types of toxicological assays, namely, developmental toxicity, cardiotoxicity, neurotoxicity, and hepatotoxicity were performed with observation and recording of lethal and sub-lethal endpoints. The effect of *ATE* on triggering apoptosis in Zebrafish embryos was studied using Acridine orange (AO) staining. The acute toxicity of the extract was assessed in zebrafish embryos by treating them with different concentrations of the extract for 24hpf and LC50 was found to be 104.47±0.29ppm. The embryo treated with higher concentrations of the extract showed deformations in the developmental stages from day 2. Delayed hatching, incomplete yolk sac consumption, defective swimming behaviour, and a decrease in heart rate were observed at the higher concentrations beyond which the embryos were dead. The exposure of zebrafish embryos to ATE resulted in disruption of the ISV formation leading to defective ISVs after 48hours post-fertilization at all the tested concentrations. ATE exhibits cell death by apoptosis mechanism in zebrafish embryos. The results showed that no developmental toxicity was observed in zebrafish embryos below 3ppm and the extract was able to induce apoptosis and reduce angiogenesis in the embryo. The study confirmed apoptosis in treated zebrafish embryos using acridine orange staining. Fluorescent signals indicated increased cell death in response to extract exposure. This apoptotic activity, coupled with anti-angiogenic effects, supports the bioactive nature of *A. terreus* metabolites and highlights their potential in anticancer drug discovery.

Keywords: ATE: Ethyl acetate Extract of *A. Terreus,* Apoptosis, toxicity

Superhydrophobic Engineering Strategies for Reducing Catheter-Associated Urinary Tract Infections: A Computational and Experimental Perspective

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Catheter-associated urinary tract infections (CAUTIs) remain one of the most prevalent healthcare-associated infections worldwide, particularly affecting intensive care unit (ICU) patients and elderly populations. Despite over a century of use, the Foley catheter continues to present unresolved challenges related to biofilm formation, encrustation, and subsequent microbial colonization. Current antimicrobial coating strategies, while effective in part, contribute to antimicrobial resistance (AMR), thereby underscoring the need for alternative engineering solutions. This study investigates the potential of superhydrophobic surface modification as a preventive approach to CAUTI.

A combined computational and experimental methodology was employed to analyze the internal hydrodynamics of a standard Foley catheter. Three-dimensional catheter geometries were modeled in ANSYS SpaceClaim (2020 R2), and flow dynamics were simulated using the ANSYS Fluent module. A custom-built flow characterization test-rig validated the computational predictions under controlled conditions with artificial urine (AU). Morphological evaluations via scanning electron microscopy (SEM) confirmed encrustation deposition in clustered and chain-like formations, while numerical simulations revealed significant turbulence and stagnation zones, particularly near the inlet region (Re = 2005–2030). These stagnation zones serve as nidus points for bacterial colonization, accelerating biofilm development.

Results demonstrated that internal catheter flow is transitional and turbulent rather than laminar, with incomplete voiding and wall adherence of fluids contributing to encrustation. The findings highlight the necessity of engineering design modifications, specifically through nano- and microstructuring to achieve superhydrophobicity, thereby promoting self-cleaning behavior and reducing bacterial adhesion. Unlike conventional antimicrobial strategies, superhydrophobic modification provides a passive, long-term preventive measure that aligns with the principle of “prevention is better than cure.” This work emphasizes the critical role of engineering innovation in medical device design and presents superhydrophobic surface engineering as a promising pathway to significantly reduce CAUTI incidence and improve patient safety.

Cytotoxic Effects of *Xenorhabdus stockiae* Metabolites on Salivary Glands of *Aedes aegypti*: Targeting Prohibitin to Disrupt Dengue Transmission

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The salivary glands of *Aedes aegypti* play a central role in viral transmission, including dengue virus (DENV), by facilitating blood feeding and modulating host immune responses. Prohibitin, a conserved 35 kDa protein expressed in the mosquito salivary glands, has been identified as a putative DENV receptor. In this study, we investigated the cytotoxic effects of metabolites from *Xenorhabdus stockiae* KUT6 on isolated salivary glands of *A. aegypti*. Histopathological analysis of larvae exposed to purified exotoxins revealed extensive damage to the peritrophic membrane and epithelial cells of the midgut, accompanied by leakage of gut contents. MTT assays demonstrated dose-dependent cytotoxicity of KUT6 metabolites, with inhibition rates of 49.4%, 62.4%, and 83.5% for 50, 100, and 150 µg/ml of sample C – 72-hour supernatant culture of *Xenorhabdus stockiae* (without quorum sensing), and 52.8%, 67.1%, and 86.0% for sample C1 - 72-hour supernatant culture of *Xenorhabdus stockiae* (with quorum sensing), respectively. SDS-PAGE analysis confirmed the absence of prohibitin bands in treated salivary gland samples, indicating proteolytic degradation. These findings suggest that quorum-sensing-optimized metabolites of *X. stockiae* target prohibitin and disrupt salivary gland integrity, thereby providing a novel mechanism to interfere with DENV transmission. This study highlights the potential application of microbial metabolites as innovative vector control strategies against dengue.

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Drug-Loaded Decellularized Scaffolds for Tendon Repair

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Achilles tendon injuries are among the most common musculoskeletal disorders, often leading to impaired mobility and reduced quality of life. Conventional treatments have limitations, whereas tissue engineering offers a promising alternative by combining scaffolds, cells, and bioactive molecules to promote functional tissue regeneration.

In this study, a cadaveric sheep Achilles tendon was decellularized using a detergent-based method (1% Triton X-100) to remove immunogenic components while preserving structural integrity. The decellularized tendon (DT) was characterized for morphological, biochemical, and mechanical properties, along with drug release kinetics. To enhance therapeutic potential, Sesbania grandiflora phytochemicals (phenols, flavonoids, terpenoids, tannins, saponins, and alkaloids), known for their anti-inflammatory, antioxidant, and regenerative properties, were incorporated into the DT.

The phytochemical-loaded DT showed sustained release of phenolic and flavonoid compounds. Raman and FTIR analyses confirmed successful phytochemical incorporation. SEM analysis revealed good cell attachment and proliferation of mesenchymal stem cells on the scaffold. Cytotoxicity assays with L929 fibroblasts and hADMSCs (human adipose derived mesenchymal stem cells) demonstrated non-cytotoxicity and cytocompatibility. Additionally, the scaffold retained favorable mechanical properties and supported cellular interactions.

The phytochemical-loaded decellularized sheep Achilles tendon scaffold preserved the native matrix structure, enabled sustained Sesbania grandiflora delivery, and exhibited favorable mechanical, biocompatible, and cellular responses. These findings highlight its strong potential as a natural, multifunctional biomaterial for tendon tissue engineering and clinical tendon repair applications.

Keywords: Tendon tissue engineering, sheep tendon, decellularization, drug delivery, scaffold, regenerative medicine, biocompatibility

A Novel Tubulin-Targeting Compound, N-(2,5-dimethoxy-4-methylphenyl), Exhibiting Potent Cytotoxicity and Mitotic Arrest in MCF-7 Cells

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Microtubules are essential components of the cytoskeleton and play a pivotal role in mitosis, making them a well-established target for anticancer therapeutics. The aim of the study is to design, synthesis and characterization of a novel small molecule that acts as anti-cancer agent by targeting microtubules to block the mitotic cell division. Here we report a small molecule inhibitor, N-(2,5-dimethoxy-4-methylphenyl) benzamide, which targets microtubule polymerization and shows specific cytotoxicity towards MCF-7 cell line. In MCF-7 cells, treatment with this compound resulted in a significantly low IC_{50} value, which is 2.75 ±0.8 µM accompanied by almost 60% mitotic blocks by 20 µM of the compound, robust apoptotic induction, and marked changes in mitochondrial membrane potential, suggesting activation of intrinsic apoptotic pathways. While in other cell lines like HeLa, A549, MDA-MB-231, HEK293 and L929 it showed comparatively higher IC50 values like 89 ± 4.1 µM, 128 ± 3.8 µM, 30 ± 1.9 µM, 75 ± 3.1 µM and 40 ± 2.4 µM respectively. Biophysical studies revealed strong binding of the compound to tubulin, with dissociation constants (KD) of 14.5 ± 2.3 µM determined through fluorescence quenching assays. Light scattering analyses confirmed disruption of microtubule polymerization dynamics, further supporting its role as a tubulin-targeting agent. Sedimentation assay showed that the polymer mass of tubulin decreased with increasing concentration of the compound which supports the outcome from light scattering assay. Notably, despite potent activity in MCF-7 cells, the lower cytotoxicity in other tested cell lines indicates a unique selectivity profile that may be linked to differential expression of microtubule-associated proteins, signaling pathways, proteins exclusively expressed in MCF-7 cell line or cellular uptake mechanisms in this breast cancer subtype. This study identifies a promising lead candidate for the development of targeted breast cancer therapies targeting microtubules. Future work will focus on elucidating the molecular determinants underlying its cell-line-specific efficacy, structural characterization of the binding interaction, and evaluation of its therapeutic potential in preclinical models.

Disruption of Z-Ring Assembly by Zerumbone: A Natural Inhibitor of Bacterial Cell Division Protein FtsZ

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FtsZ (Filamenting temperature-sensitive mutant Z), a highly conserved bacterial tubulin homolog, polymerizes into a dynamic cytokinetic Z-ring at the mid-cell and orchestrates septum formation during cell division. Due to its vital role in bacterial cell division and its highly conserved nature, it offers a promising target for the development of antibacterial drugs. In this work, we investigated the antibacterial potential of Zerumbone, a natural sesquiterpene, against both Gram-positive (*Bacillus subtilis* 168) and Gram-negative (*Escherichia coli* XL-1) bacterial strains. Zerumbone was isolated from the rhizomes of the *Zingiber zerumbet* through Hydrodistillation and was characterised using various techniques such as FTIR, LC-MS, NMR, and powder XRD. Zerumbone inhibited the growth of *B. subtilis* and *E. coli* XL-1 in a concentration-dependent manner, with IC_{50} values of 49 µM and 53 µM, respectively. Treatment with Zerumbone caused an abnormal elongation in the average length of the bacterial cells, suggesting that it inhibits cell partitioning. Live-cell fluorescence imaging of *B. subtilis* PL642 expressing GFP-tagged FtsZ confirmed that Zerumbone impaired Z-ring formation, resulting in mislocalized FtsZ throughout the cell. Furthermore, Zerumbone bound to purified E. coli FtsZ (EcFtsZ) with a dissociation constant (Kd) of 24 µM ± 4 and inhibited FtsZ assembly in vitro. Molecular Docking analysis suggested that Zerumbone bound to FtsZ through various hydrophobic interactions and hydrogen bonding. Molecular dynamics simulations of Zerumbone with FtsZ revealed that the Zerumbone-bound complex exhibited a sharp rise in RMSD after 50 ns, indicating that Zerumbone induced conformational changes in the FtsZ protein. All of the findings demonstrate the potential of the natural sesquiterpene Zerumbone as a lead molecule for the development of antibacterial agents and as a powerful inhibitor of bacterial growth.

A Novel Off-Target Interaction between Human Thiopurine S-Methyltransferase and Telmisartan: Implications for Severe Immunosuppressive Drug Toxicity

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Thiopurine S-methyltransferase (TPMT) is a cytosolic enzyme responsible for catalyzing the S-methylation of aromatic and heterocyclic sulfhydryl compounds. While its endogenous substrate remains unknown, TPMT is essential for regulating the metabolism and therapeutic effectiveness of thiopurine immunosuppressant drugs. Given the crucial role of TPMT activity in drug metabolism, patients with a deficiency are at high risk of fatal toxicity from standard thiopurine drug doses. Therefore, TPMT activity testing is recommended for safe, personalized therapy. Here, we tested whether TPMT is susceptible to off-target interaction with most commonly prescribed antihypertensive drug telmisartan. Through comprehensive molecular modeling, this study demonstrates for the first time that telmisartan binds within the TPMT active site. This interaction effectively obstructs the binding pockets for both the co-factor and the thiopurine substrate, while maintaining the integrity of overall secondary structure of TPMT. The interconnected nature of the co-factor and thiopurine substrate binding pockets provides favorable interactions and spatial complementarity that enhance telmisartan's binding affinity, surpassing that of TPMT's natural co-factors. This work uncovers a previously unrecognized mode of interaction between TPMT, a key biomacromolecule in thiopurine drug metabolism, and telmisartan. These findings emphasize the need for further investigations into potential adverse effects arising from telmisartan co-administration with thiopurine-based immunosuppressants.

Synergistic Approach to Bone Regeneration using Green-Synthesized Magnesium Oxide nanoparticles loaded with Bioactive Plant Extract

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Bone defects arising from trauma, infection, or metabolic disorders present significant clinical challenges due to impaired natural regeneration mechanisms, especially in cases of large or complex defects. Conventional treatments often involve autografts or synthetic biomaterials, but limitations such as donor scarcity, risk of infection, inadequate vascularization, and poor integration remain unsolvable. Researchers are now been focusing on synthesizing nanoparticle using chemical methodologies for bone-regenerative materials, including Magnesium oxide nanoparticles (MgO), typically require hazardous reagents or conditions that may introduce toxic by-products, reduce biocompatibility, and hinder the healing process due to residual contaminants or inflammatory responses. These drawbacks underscore the urgent need for eco-friendly, biocompatible alternatives that can promote osteogenesis while minimizing risks associated with synthetic chemicals and adverse immune reactions. In our study introduces an innovative, sustainable strategy for bone tissue engineering by harnessing the synergistic potential of naturally synthesized magnesium oxide (MgO) nanoparticles from fruit waste and a bioactive plant extract with osteogenic properties. MgO nanoparticles, produced via green synthesis using phytochemical-rich waste, have high biocompatibility, antioxidant activity, and sustained Mg^{2+} release, supporting cellular proliferation and mineralization essential for bone repair. Simultaneously, the selected plant extract is recognized for promoting osteogenic differentiation and enhancing regeneration outcomes. By blending these two bioactive agents which results eco-friendly nanocomposite. This synthesized nanocomposite was characterized using XRD, FTIR, SEM/EDX, FESEM, and zeta potential analysis to examine the structural and morphological properties. The plant extract is screened for phytochemicals, and its bioactivity is assessed via assays like antioxidant, anti-biofilm, and anti-microbial tests. This eco-friendly composite approach not only valorizes agricultural waste and plant resources but also offers an effective, scalable pathway for next-generation, minimally invasive bone regeneration therapies.

Phytochemical-Enriched Nano-hydroxyapatite Reinforced into Polymeric Cryogel Scaffolds for Bone Regeneration

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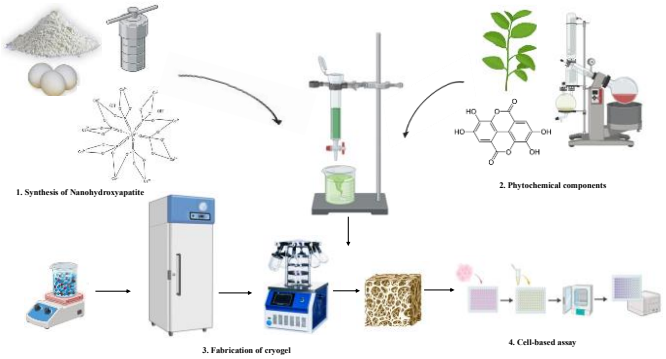
Osteoporosis leads to reduced bone density and strength, increasing fracture risk due to an imbalance in bone formation and resorption. Which risk of fractures and is influenced by aging, lifestyle changes, and nutritional inadequacies. Adverse effects, poor adherence, and costs limit the effectiveness of current treatments, such as autologous bone transplants and bisphosphonates. To handle its increasing burden, safer, more innovative approaches combining cutting-edge regenerative therapies and early diagnostics are vital. The development of polymeric cryogel scaffolds combined with nanocomposites, like phytochemical-loaded nanohydroxyapatite, has grown into an effective strategy for bone regeneration to overcome this challenge. The sponge-like flexibility and highly interconnected macroporous structure of cryogel promote tissue ingrowth, nutrient transport, and cellular penetration. Cryogel are also capable of being precisely sized and shape memory effect to fit bone defects and provide outstanding mechanical stability. By loading plant-based compounds onto eggshell-derived nanohydroxyapatite, the enhancement of biocompatibility combines phytochemicals that possess antibacterial, anti-inflammatory, and antioxidant properties with a natural, porous, and bioactive scaffold closely resembling bone composition. Cell viability is maintained, osteogenic activity is stimulated, and this cooperative integration reduces cytotoxicity. For bone tissue development and healing, the composite material thus provides an ideal environment.

Keywords: Nanohydroxyapatite, Eggshell waste, Polymeric Cryogel, Tissue Engineering, Phyto-therapeutics



Mimicking Exercise and Enriched Environment Through Drug Repurposing: Doxepin as a Novel Post-Ischemic Neuroprotective Candidate

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Ischemic stroke is a major global cause of mortality and long-term disability, with existing treatments primarily limited to reperfusion strategies like thrombolysis and mechanical thrombectomy, which suffer from strict time constraints and eligibility restrictions. Consequently, alternative approaches to improve neuroprotection and functional recovery are urgently needed. Preclinical studies highlight that interventions such as enriched environment exposure and physical exercise can significantly enhance synaptic plasticity, neurogenesis, angiogenesis, and resistance to ischemic damage. Despite these benefits, directly translating such practices to clinical settings is hindered by logistical challenges and patient adherence issues, emphasizing the necessity for pharmacological mimetics. Drug repurposing provides an efficient pathway to identify new indications for approved drugs, accelerating therapeutic development. Utilizing bioinformatic analyses, this study identified doxepin—a tricyclic antidepressant commonly prescribed for depression and insomnia—as a promising pharmacological mimic of enriched environment interventions and exercise. Subsequent validation in the oxygen-glucose deprivation (OGD) model demonstrated that doxepin confers marked neuroprotective effects post-ischemia. These findings propose doxepin as a candidate for adjunctive neuroprotection in stroke, illustrating the potential of integrating computational drug discovery with mechanistic experimental validation to advance stroke therapeutics.

Keywords: Ischemic stroke, Environment enrichment; Exercise; Differentially Expressed Genes; Doxepin; Post-ischemic neuroprotection.

3D Bio-printed Pulmonary Constructs: A Review on Lung Tissue Engineering and Applications

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Humans and animals may become infected with diseases, face stress or trauma, or undergo physiological changes caused by congenital defects. These issues can result in damage, malfunction, and ultimately the loss of tissues & organs. Since humans have low regenerative potential, transplantation or replacement of damaged tissue or organs is often necessary. Relying solely on transplantation has resulted in long waiting lists for organ transplants. Scientists are working on advanced technologies like 3D bioprinting and strategies to improve tissue and organ regeneration, aiming to create new artificial tissues and organs. 3D bioprinting offers great potential for printing artificial tissues and organs, which could transform regenerative medicine. However, tissue engineering and 3D bioprinting research have mostly focused on simpler tissues due to challenges in creating artificial constructs for complex tissues.

3D bioprinting of structures like lungs faces its own challenges due to its complexity and vasculature. Reproducing the alveolar epithelium and the vascular interfaces was beyond the resolution of 3D bioprinting in 2021. For 3D printing pulmonary constructs, the complicated geometries, the blood-air barrier, and the dynamic cellular environment of lungs must be mimicked to achieve a fully functional lung construct. Recently, bio-printed lung-on-a-chip models, blood-air barrier models, and 3D lung cancer models have been reported. Despite advances in developing pulmonary constructs or using other biofabrication techniques, the field remains in its early stages, presenting both challenges and opportunities for improving bioinks and printing protocols.

A bioinspired 3D Printed Sodium Alginate/Chitosan Scaffold Loaded with *Cissus quadrangularis* extract for cancellous alveolar bone regeneration

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Development of polymer-based scaffolds incorporating phytomolecules is crucial for enhancing the osteogenic properties of polymeric bone substitutes. In this study, novel 3D printed scaffolds composed of sodium alginate (SA) and chitosan (CH), loaded with *Cissus quadrangularis* (CQ) seed extract, were successfully fabricated, and their morphology was characterized using scanning electron microscopy (SEM). Incorporation of CQ extract in SA/CH scaffold improved the hydrophilicity and biodegradation rate of the scaffolds. A sustained release profile of CQ extract was observed across all scaffolds. Anti-oxidant property of the scaffold was enhanced remarkably by the addition of CQ extract in dose dose-dependent manner. Addition of CQ extract in optimal dosage, such as 0.125% and 0.25% (w/v), in SA/CH 3D matrix remarkably improved the cell viability of human osteoblast like Saos-2 cells. However, decreased in cell viability was seen at higher concentration of extract as evidenced in SA/CH/$CQ_{0.5}$ and SA/CH/$CQ_{1.0}$ constructs. Cell adhesion study demonstrated that SA/CH/$CQ_{0.25}$ 3D construct exhibited a greater density of attached cells with stretched filaments compared to others. Biomineralization and ALP activity analyses revealed that the SA/CH/$CQ_{0.25}$ construct, followed by SA/CH/$CQ_{0.125}$, exhibited the highest osteogenic activity among all tested constructs. As the SA/CH/$CQ_{0.25}$ scaffold showed superior physico-chemical and osteogenic performances, hence acts as a potential bone substitute for the regeneration of cancellous alveolar bone.

Keywords: 3D printing, Alveolar bone, Chitosan, *Cissus quadrangularis*, Sodium alginate

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Characterizing Physicochemical, Entropy and DNA Shape features to Differentiate Replication Protein Binding Sites in *Plasmodium falciparum*

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Malaria, caused by the protozoan *Plasmodium falciparum*, remains a major global health burden. The parasite proliferates by replicating its genome using the host's cellular machinery. Studying replication origins, particularly the binding sites of key pre-replication complex proteins PfMCM6 and PfORC1, can provide insights into sequence composition and regulatory mechanisms in *P. falciparum*.

In this study, we analyzed DNA binding sequences of PfMCM6 and PfORC1 using ChIP-Seq data to examine their structural and physicochemical profiles. We assessed DNA sequence diversity, conformation, and energetics by computing Shannon entropy, DNA shape features, hydrogen bonding, stacking interactions, and solvation energies.

Our findings reveal distinct patterns in entropy, physicochemical properties, and DNA shape that differentiate PfMCM6 and PfORC1 binding sites from non-binding regions. Leveraging these features, we developed two classification models using the XGBoost algorithm, achieving accuracies above 90%.

This study highlights the potential role of physicochemical properties in shaping DNA sequence preferences for PfMCM6 and PfORC1 binding, thereby providing new insights into DNA–protein interactions and replication initiation mechanisms in the *P. falciparum* genome.

Identification and Characterization of TPP Riboswitch in *Adhatoda vasica*: Insights into Regulatory Control of Alkaloids

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Non-coding RNAs (ncRNAs) play critical roles in regulating gene expression, extending beyond the primary function of DNA as an information store. Among them, riboswitches are structured ncRNAs (50–250 nucleotides) located in untranslated regions (UTRs), with the thiamine pyrophosphate (TPP) riboswitch being the best characterized. In plants, riboswitches typically occur in the 3′ UTR and regulate genes such as THIC, which is essential for thiamine biosynthesis.

Adhatoda vasica (Vasaka) is a medicinal plant widely used for treating respiratory disorders, diabetes, and rheumatic conditions. Its therapeutic potential is primarily attributed to quinazoline alkaloids such as vasicine, yet the role of ncRNAs in regulating its secondary metabolism remains unexplored. In this study, we investigated the presence of TPP riboswitches and their association with the THIC gene in *A. vasica*. Genome-wide searches using the INFERNAL tool identified four putative TPP riboswitches, of which one was selected based on stringent E-value thresholds. Sequence validation was performed using BEDTOOLS, and the secondary structure was predicted with FORNA. Comparative analysis with *Arabidopsis thaliana* confirmed conserved riboswitch–THIC features. This is the first report of a TPP riboswitch in *A. vasica*. The findings highlight riboswitch-mediated regulation as a potential target for synthetic biology approaches to enhance alkaloid biosynthesis in medicinal plants.

Comparative Analysis of Molecular Methods for the Detection of *Salmonella enterica* in Seafood

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Seafood often harbours non-typhoidal *Salmonella enterica*, a leading agent of foodborne gastroenteritis across the globe. Rapid methods for its detection are important for monitoring seafood safety. This study focused on the development of a recombinase polymerase amplification (RPA), assay based on the principle of isothermal amplification, for detecting *S. enterica* in seafood. Primers targeting the *invA* gene coding for invasion protein were designed and custom-synthesized for RPA detection. The RPA conditions were optimized at 41°C for 30 minutes, and the amplification products were visualized through agarose gel electrophoresis. The method proved specific to amplifying the target *invA* gene exclusively, as confirmed by testing with two *Salmonella* serotypes and six non-*Salmonella* strains. Further, it could detect *Salmonella* cells up to a limit of 10^6 CFU/ml both in pure bacterial culture and spiked shrimp. RPA was also successfully validated by screening for *Salmonella* in commercial seafood samples, where it detected two (13%) out of 15 samples positive. Additionally, real-time PCR assays were developed by targeting *invA* and *hilA* genes in *S. enterica*. The primers at their optimized annealing temperature of 61°C demonstrated high specificity towards the target genes when tested against various *Salmonella* and non-*Salmonella* strains. The invA primer detected concentrations as low as 10^3 CFU/mL, while the hilA primer could detect up to 10^4 CFU/mL in both pure bacterial culture and spiked shrimp, respectively. The study also compared the efficiency of FDA-approved Sal 1598 primer for *Salmonella* detection by RT PCR, revealing its identical sensitivity limit with RPA. The analytical sensitivity of the developed RPA was lower compared to real-time PCR; however, it demonstrated excellent amplification at a significantly reduced temperature and time, without the need for any sophisticated equipment. Further improvements in the RPA method could lead to a promising tool for the point-of-care detection of *S. enterica* in seafood.

Development of hBN-Ag-TiO2 Nanocomposite Coatings for Antibiofouling and Anti- Biocorrosive application

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Marine biofouling, characterized by the persistent formation of biofilms on the surfaces of water vessels, results in severe operational inefficiencies and accelerated material degradation. Several coatings are utilized on marine equipment for preventing damage from fouling organisms. This study investigates the efficiency of utilizing hBN-Ag-TiO_2 (hBN/A/T) - incorporated polyurethane (PU) coatings on mild steel as an effective solution for anti-biofouling and anti-biocorrosion. The nanocomposites were synthesized using the liquid-phase exfoliation technique and were characterized using several microscopic techniques.

The antibacterial tests were performed on two microbial strains, Staphylococcus aureus (SA) and Pseudomonas aeruginosa (PA), and revealed both Minimum Inhibition Concentration (MIC) and Minimum Bactericidal Concentration (MBC) of 400 µg/mL for PA and 800 µg/mL for SA. The anti-biocorrosion tests were performed by submerging the spin-coated nanocomposite coatings (PU, hBN, hBN/A/T, and A/T) and the bare mild steel substrate (control) in the microbial suspension for 5 days. The results of bacterial attachment were observed by Field Emission Scanning Electron Microscope.

Keywords: Marine Antibiofouling, Anti-biocorrosive, Coatings, hBN/Ag-TiO2 nanocomposite

Probe Sonication-Based Apparatus and Method for Dissolution Testing of Oral Solid Dosage Forms

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The invention relates to the field of pharmaceutical analysis and more particularly to an apparatus and a method for dissolution testing of oral solid dosage forms using probe sonication. The apparatus comprises a dissolution vessel, a holder configured to secure the dosage form in a fixed position, and a probe sonicator system that generates controlled acoustic cavitation. A control unit regulates sonication in intermittent pulse cycles to balance dissolution efficiency with thermal control. This method drastically reduces testing time compared to conventional techniques. At least 80% of the labelled drug from an immediate-release dosage form is released in not more than 10 minutes, and in not more than 120 minutes for an extended-release dosage form. The drug's chemical stability is maintained throughout the process.

Complete Chemical Synthesis of Minimal Messenger RNA by Efficient Chemical Capping Reaction

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Since the COVID-19 pandemic, messenger RNA (mRNA) has gained global attention as an important tool for vaccines and therapeutics. A key feature of mRNA is the 5′ cap structure, which protects it from degradation and enables efficient protein translation. Traditional enzymatic capping methods often show incomplete efficiency and limited flexibility for chemical modifications.

Here, we present a purely chemical method to synthesize and cap short mRNAs using N7-methylated GDP imidazolide (Im-m7GDP) in an organic solvent system. This approach achieved over 90 % capping efficiency for 5′-phosphorylated RNAs up to 107 nucleotides within three hours, providing a robust enzyme-free alternative.

We also prepared site-specifically modified mRNAs with N6-methyladenosine, non-nucleotide linkers, and 2′-O-methyl groups. Translation experiments in HeLa cells demonstrated that modifications in untranslated regions were well tolerated, whereas changes in coding regions reduced activity. Importantly, RNAs with Cap-2 showed significantly higher protein expression compared to uncapped or Cap-0 RNAs.

This study demonstrates that complete chemical synthesis provides precise control over mRNA design, offering a versatile platform for next-generation RNA-based vaccines and therapeutics in the post-COVID-19 era.

Design, Synthesis and Biological Evaluation of Novel quinazoline derivatives as Antioxidant agents: In vitro, Cell based and Molecular Docking studies

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Four new quinazoline derivatives were synthesized and structurally characterized. One derivative was obtained as a crystal and determined by using single-crystal X-ray diffraction, while the remaining compounds were investigated using different spectroscopic methods. Among these, the bromine-substituted derivatives showed strong antioxidant activity, with the most active molecule having an IC_{50} value of 87 µM. In cell-based studies, these active compounds strongly protected L929 fibroblast cell lines from oxidative stress. And from the molecular docking studies, it provides their binding interactions with an important oxidative stress-related enzyme, showing favourable binding affinities and probable modes of action. These findings suggested that bromine-substituted quinazolines are interesting candidates for further research as preventive agents against oxidative stress.

Keywords: Quinazoline, oxidative stress, antioxidant activity

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Colorimetric and Spectroscopic Detection of Arsenite: DFT and Test Strip Applications

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A novel receptor 3'-HAPCN was designed, synthesized, and evaluated for its sensing properties. It exhibits a remarkable selectivity towards arsenite ion over the other tested ions in ethanol. A distinct naked eye colour change has been observed from pale yellow to bright orange. A Uv-Vis titration study revealed a significant bathochromic shift from 370nm to 462 nm, indicating the interaction of the receptor 3'-HAPCN with AsO_2^-. The presence of isobestic point confirms the complex formation, which is further supported by a DFT study. Arsenite, being a strong base, abstracts the acidic proton from the phenolic –OH of 3'-HAPCN, resulting in a red shift. The binding constant was calculated from the B-H plot and found to be **7**.96 × 10^4 M^{-1}, with the limit of detection 0.64 ppm. The test strip study displayed a positive response towards arsenite ions.

Keywords: 3'-HAPCN, Arsenite, UV- Vis titration, DFT study, Test strip application.

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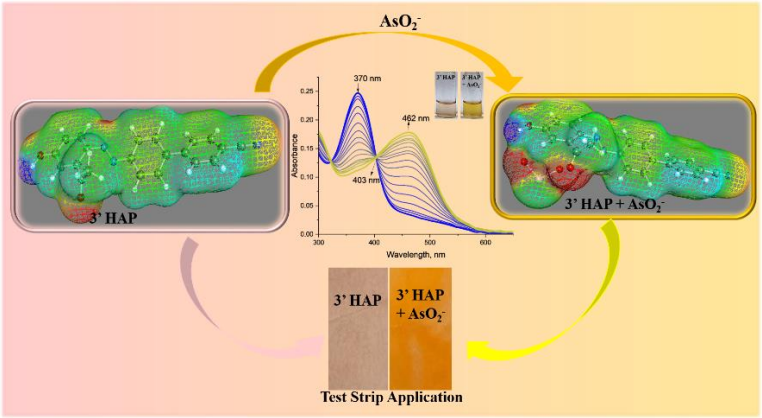

Sustainable Upcycling of Biodegradable Plastic Waste into Carbonized Polymer Dots and their MOF and Hydrogel Composites as Efficient Turn-Off-On Sensors of Fe^{3+} and Cysteine

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The sustainable management of plastic waste presents a crucial challenge due to environmental concerns associated with biodegradable plastics. In this work, we report an innovative upcycling for biodegradable plastic waste, specifically pink carry bags, by synthesizing carbonized polymer dots (CPDs) with promising 'turn-off-on' sensing applications towards cysteine. The process involves melting the plastic bags at 200 °C, followed by dispersion in ethanol, yielding CPDs exhibiting strong yellowish-orange fluorescence under UV excitation. These CPDs are further utilized to fabricate composite materials: first, by encapsulation within non-fluorescent Metal-organic framework (MOF) namely ZIF-8 to create a CPD@ZIF-8 composite; and second, by embedding in a poly(vinyl alcohol) hydrogel matrix crosslinked with glutaraldehyde. Spectroscopic analysis reveals that CPD, CPD@ZIF-8 and CPD@Hydrogel display selective fluorescence quenching ("turn-off") in the presence of Fe^{3+} ions under 290 nm excitation, indicating effective sensing ability. Notably, subsequent introduction of cysteine ("turn-on" step) restores the original fluorescence intensity of the CPDs in CPD solution, MOF and hydrogel composites, evidencing their reversible and selective response. These findings underscore the dual benefit of plastic upcycling and development of efficient, eco-friendly, reversible sensors for Fe^{3+} and cysteine, paving the way for potential applications in environmental monitoring and biomedical diagnostics.

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Substitution-Driven Modulation of Intramolecular Charge Transfer in Anthracene-Based π-Conjugated Systems: Insights from Stark Spectroscopy and TD-DFT Analysis

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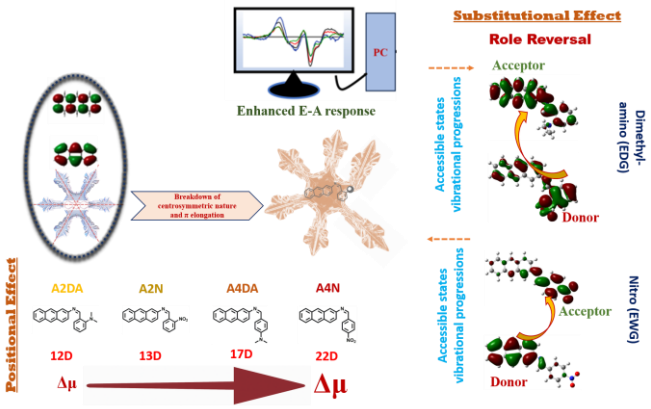
Anthracene derivatives have shown promising applications in organic photovoltaics, non-linear optical materials, fluorescent probes, and chemical sensors due to their high quantum yield and charge transfer (CT) properties. The impact of molecular symmetry and substituent positioning on the charge-transfer (CT) behavior of π-conjugated systems was investigated through the design of four novel imine derivatives of 2-aminoanthracene. Electron-donating ($–N(CH_3)_2$) and electron-withdrawing ($–NO_2$) groups were introduced at the ortho and para positions of the pendant aryl aldehyde moieties to modulate intramolecular charge transfer (ICT) characteristics. Steady-state absorption spectra revealed significant red- or blue-shifts in the CT band depending on substituent identity and position, accompanied by perturbation of vibronic structure. TD-DFT calculations confirmed that the nature and localization of the frontier molecular orbitals dictate the direction and extent of ICT. Electro-absorption (Stark) spectroscopy enabled us to extract important excited-state parameters, including dipole moment changes (Δμ) and polarizability differences (Δα), validating the field-sensitive nature of the transitions. These results demonstrate how substitution-driven symmetry breaking and orbital reorganization modulate the excited-state character and electronic transitions. The structure–property correlations revealed here provide valuable insight to design principles for next-generation materials in chemical sensors, organic photonics, nonlinear optics and molecular electronics.



Rational Design, Synthesis of Colorimetric Sensor for the Discrimination of Phosphate & Carbonate from Aqueous Samples

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In this work, Schiff base chemosensor (R1) has been designed, synthesized, and characterized for the selective colorimetric detection of ions of environmental and biological relevance. Receptor R1 was synthesized through the condensation of 4-(diethyl amino) salicylaldehyde with 4-nitrobenzoic hydrazide. Resulted Synthesized receptor was further characterized by IR, 1H NMR, and UV-Vis spectroscopy. UV–Vis titration and cyclic voltammetry studies revealed that the receptor exhibit pronounced selectivity and sensitivity toward phosphate and carbonate ions, producing distinct color changes readily detectable by the naked eye. Benesi–Hildebrand analysis confirmed a 1:2 (receptor: anion) binding stoichiometry with both anions. Binding constants, limits of detection (LOD), and limits of quantification (LOQ) were determined to assess sensing efficiency. R1 exhibited LOD values of 1.61 ppm for phosphate (PO_4^{3-}) and 1.43 ppm for carbonate (CO_3^{2-}), with binding constants of 2.81×10^9 M^{-2} and 2.63×10^9 M^{-2}, respectively. Additionally, Computational studies using DFT further supported experimental findings by illustrating changes in molecular geometry and electronic properties upon complexation.

Furthermore, the practical applicability of R1 was demonstrated using paper strip tests, confirming its potential as a simple, cost-effective, and efficient colorimetric probe for anion sensing in environmental and biological systems.

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Nanosilver Incorporated Aqueous Processable Graphene Catalyst for Efficient Reduction of 4-Nitrophenol to 4-Aminophenol

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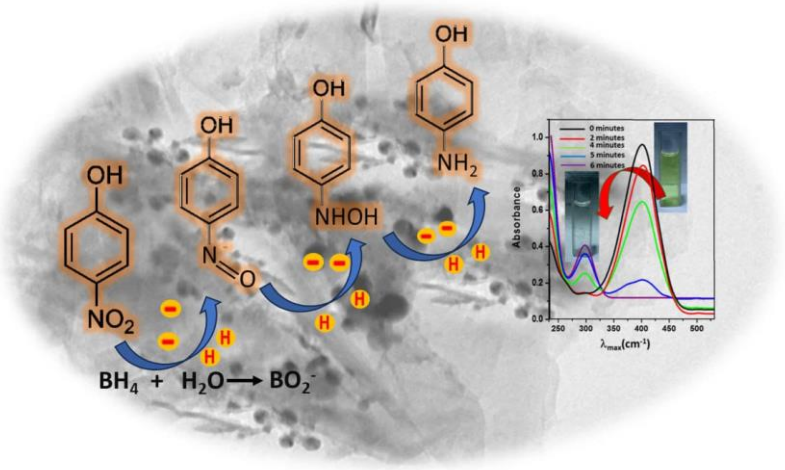
Herein, a facile and green ball-milling strategy was employed for the scalable synthesis of aqueous processable graphene (GN) from graphite in the presence of sucrose as the milling agent. A simple hydrothermal treatment of aqueous dispersion of graphene stabilized by sucrose in the presence of silver nitrate is performed to produce nanosilver decorated graphene nanocomposites (nAg/Gs). Here, rather than acting as a milling agent and as a stabilizer for graphene aqueous dispersion, sucrose works as the reducing and capping agent of silver nanoparticles during the hydrothermal treatment. The produced graphene is less defective when compared to other graphite exfoliation techniques, as evident from various characterization methods. The catalytic activity of GN and nAg/G were studied in the reduction of 4-nitrophenol to 4-aminophenol with the use of $NaBH_4$ as the reducing agent and it is found that the activity of the nAg/Gs are significantly higher when compared to GN.



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Synthesis, Structural Characterization and Biological Evaluation of Benzothiazole Derivatives as Anticancer Agents

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Benzothiazole derivatives and their transition metal complexes have attracted considerable attention due to their structural versatility and wide range of biological activities. In the present work, new complexes of benzothiazole-based ligands with Cu(II), Ni(II), and Zn(II) salts were synthesized and fully characterized by elemental analysis, spectral techniques, and thermal studies. Single-crystal X-ray diffraction confirmed the precise coordination geometries and molecular arrangements in the solid state.

The biological potential of the complexes was evaluated through in vitro studies against MCF-7 breast cancer cell lines. Cytotoxicity was assessed using the MTT assay, which revealed that the metal complexes exhibited stronger antiproliferative activity compared to the free ligand. Apoptotic features were further confirmed by acridine orange/ethidium bromide staining, showing characteristic morphological changes of programmed cell death. DNA binding studies indicated significant affinity for nucleic acids, suggesting an intercalative or groove-binding interaction. Moreover, agarose gel electrophoresis experiments demonstrated efficient DNA cleavage, indicating a plausible mechanism for their anticancer action.

Overall, this study establishes that benzothiazole-derived transition metal complexes combine well-defined crystalline structures with promising anticancer activity. These findings reinforce the potential of benzothiazole scaffolds as valuable platforms for the development of novel therapeutic agents.

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Carbon Upcycling: From Waste to FLG for Greener Construction Materials

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This study investigates a sustainable approach to synthesizing few-layer graphene (FLG) from carbonaceous waste materials, including biomass residues, municipal solid waste, and industrial carbon byproducts. By employing innovative pretreatment techniques—such as thermal, chemical, and mechanical processing—the study aims to significantly reduce the energy consumption and cost typically associated with graphene production.

The upcycled FLG will be incorporated into civil engineering materials like concrete, asphalt, and polymer composites to enhance their mechanical properties, durability, and thermal performance. This integration supports a circular economy model, transforming waste into high-value nanomaterials for infrastructure applications.

Key objectives of the study include:

- Designing scalable, low-energy pretreatment protocols for carbon waste conversion.
- Characterizing FLG using Raman spectroscopy, SEM, and XRD to assess quality and yield.
- Evaluating FLG-enhanced construction materials for compressive strength, crack resistance, and service life.
- Analyzing environmental and economic benefits through lifecycle assessment.

By bridging nanomaterials science with civil engineering, this study offers a promising route toward green construction technologies and waste valorization.

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Ionic Conductivity of Co-Doped Ceria as Electrolyte for Solid Oxide Fuel Cells

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Solid oxide fuel cells (SOFCs) are designed to use the hydrogen gas as the fuel towards the development of green energy devices. The oxide-ion conducting ceramics such as (YSZ, $Zr_{0.92}Y_{0.08}O_{2-\delta}$) and CeO_2 based materials are used as electrolytes in SOFCs. Large number of oxide ion electrolytes have been investigated for intermediate temperature (500-800 ^{0}C) SOFCs [1-4]. Systematic investigation is made on the CeO_2-based solid electrolytes for IT-SOFC to replace the high temperature YSZ [5-7]. Thus, solid electrolytes having conductivity around 0.1 S cm^{-1} at intermediate temperatures with cost-effectiveness is required. Further, many electrolytes fall short with respect to cost, fabrication, operating temperatures and electronic leakage issues. Therefore, the co-doped ceria prepared by auto combustion method are considered to be potential electrolyte material. For instance, SDC10 ($Ce_{0.9}Sr_{0.1}O_{2-\delta}$), SDC20 ($Ce_{0.8}Sr_{0.2}O_{2-\delta}$), LSDC10 ($Ce_{0.9}La_{0.05}Sr_{0.05}O_{2-\delta}$), LSDC20 ($Ce_{0.8}La_{0.1}Sr_{0.1}O_{2-\delta}$) sintered at 1200 °C was characterized for their structural, microstructural, and ionic conductivity by ac-impedance method, **Fig. 1**.

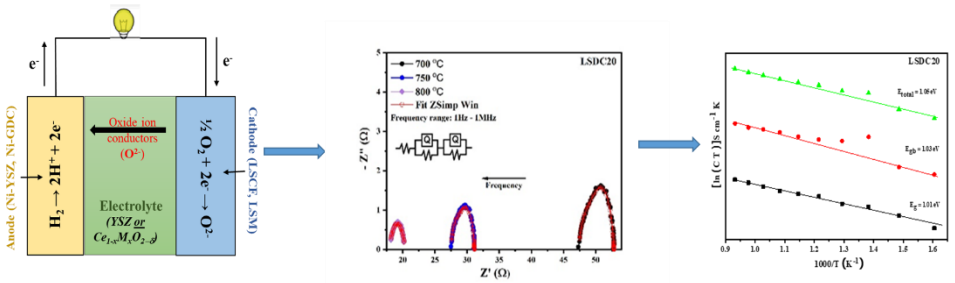

Fig. 1. (**a**) Schematic representation of SOFC (**b**) Nyquist plots and (**c**) Arrhenius plots for LSDC20, as a typical case.

The SDC10, SDC20, LSDC10 and LSDC20 exhibited the ionic conductivity of 1.48 × 10^{-2}, 1.53 × 10^{-2}, 5.27 × 10^{-2} and 1.27 × 10^{-1} S cm^{-1} at 800 °C with a lower activation energy of 1.09, 0.98, 1.15, and 1.05 eV respectively. Based on Wagner's polarization, the ionic (t_{ion}) and electronic (t_{ele}) transference numbers were found to be 0.975 and 0.025 at 700 °C, respectively. The higher ionic conductivity in LSDC20 when compared to conventional YSZ is attributed to enhanced oxygen ion mobility via a defect mechanism. Thus, Sr^{2+} and La^{3+} co-doped ceria is proposed to be potential electrolyte for intermediate temperature SOFC.

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A Dicyanovinyl-Based Fluorescent Probe for Rapid and Selective Detection of Cysteine with a Large Stokes Shift

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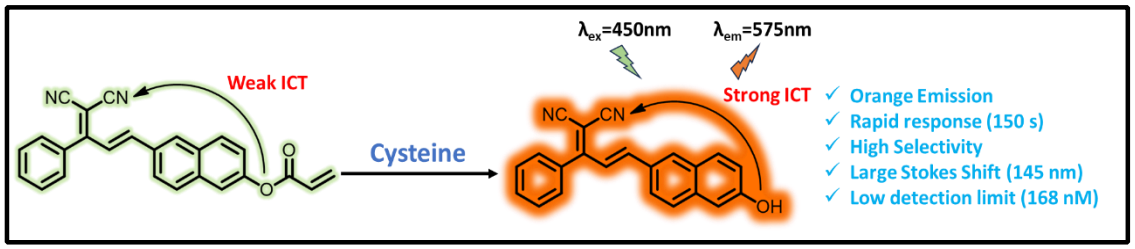
Cysteine (Cys), an essential sulphur-containing bio thiol, plays a critical role in redox balance, protein structure stabilization, and metabolic regulation, while its abnormal levels are closely associated with disorders such as neurodegeneration, liver injury, and cardiovascular disease. Therefore, the development of efficient fluorescent probes for Cys detection is of great importance. Herein, we report a Dicyanovinyl-based turn-on fluorescent probe, (E)-6-(4,4-dicyano-3-phenylbuta-1,3-dien-1-yl) naphthalen-2-yl acrylate (DCNA), which exhibits bright orange emission with a rapid response towards Cys within 150 seconds. The probe displays a large Stokes shift of 145 nm, minimizing background interference, and demonstrates excellent selectivity for Cys over related bio thiols and other potential interferents. With a low detection limit of 168 nM, DCNA provides a sensitive, selective, and readily accessible platform for Cys detection in biological systems and food samples.



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Design and Evaluation of Fused Thiophene-Benzimidazole Conjugates Targeting EGFR: Insights into Cell Cycle Arrest, Apoptosis, and Kinase Inhibition

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Benzimidazole and thiophene are well-known pharmacophores with diverse biological activities, particularly anticancer potential.[1] Their hybridization has been explored extensively, yet no thiophene–benzimidazole hybrids have emerged as effective anticancer agents.[2] To address this gap, we designed and synthesized acetamide-linked fused thiophene–benzimidazole hybrids, structurally validated by spectroscopy and single-crystal XRD. These compounds were evaluated for anticancer activity against PANC1 and A549 cell lines via MTT assay, along with cytotoxicity testing in BEAS-2B cells. All hybrids exhibited promising activity (IC50: 0.07–42.02 Mm; SI: >300), while some showed negligible toxicity in normal cells (IC50 > 50 μM), highlighting their selectivity. Mechanistic studies in A549 cells showed that two compounds induced G0/G1 cell-cycle arrest, altered cyclin expression, and activated apoptosis via modulation of apoptotic gene networks. Western blot analysis further demonstrated >60% reduction in p-EGFR/EGFR levels, confirming significant inhibition of EGFR phosphorylation. Molecular docking revealed strong binding to EGFR (PDB: 1M17), suggesting EGFR inhibition as a potential mechanism.[3]

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CO_2 capture with an Eco-Designed Cellulose and Calcium Framework

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The increasing concentration of atmospheric CO_2, largely driven by industrial activities, poses significant challenges to climate stability. Conventional sequestration methods, such as afforestation, face scalability limitations, necessitating alternative carbon capture solutions. This study explores a novel approach integrating biowaste-derived cellulose from sugarcane bagasse with amine-based solvents to enhance CO_2 absorption and conversion. The research investigates the efficiency of cellulose in combination with NaOH, $Ca(OH)_2$, and ZnO for CO_2 sequestration, analyzing weight gain, pH changes, and morphological transformations using SEM and FTIR spectroscopy. Results indicate that $Ca(OH)_2$-based treatments exhibit higher CO_2 absorption efficiency compared to NaOH, while ZnO addition enhances NaOH performance. Although $Ca(OH)_2$ demonstrates significant sequestration potential, its environmental footprint suggests that NaOH-ZnO combinations offer a more sustainable alternative. These findings contribute to the development of cost-effective, eco-friendly carbon capture solutions, bridging the gap between sustainability and industrial applicability.

Keywords: Carbon capture, cellulose-based sequestration, sugarcane bagasse, CO_2 absorption, NaOH/$Ca(OH)_2$ interaction.

Engineering Ionic Liquid Properties through Alkyl Chain Variation: Insights into Silicone Oil Miscibility and Lubricant Potential

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Designing Ionic liquids that are soluble in silicon oil has emerged as a promising trend as it significantly enhances their tribological properties[1]. In this work a series of silicon-based ionic liquids (ILs) featuring variable alkyl chain lengths—[**SiNC$_8$**][**Cl**], [**SiNC$_{10}$**][**Cl**], and [**SiNC$_{12}$**][**Cl**]—were synthesized and systematically examined to understand their solubility behavior and interactions with silicone oil. These ILs displayed distinct physical and thermal characteristics that were markedly influenced by the length of the alkyl chains. With increasing chain length, a progressive enhancement in density, viscosity, and thermal stability was observed, as validated through viscosity measurements, surface tension analysis, differential scanning calorimetry (DSC), and thermogravimetric analysis (TGA). To further enhance their physicochemical properties, the chloride anion (Cl^-) in the ILs was replaced with bis(trifluoromethylsulfonyl)imide (NTf_2^-) via a metathesis reaction. The modified ILs were then blended with silicone oil at varying ratios to evaluate their compatibility and effect on mixture viscosity. The study revealed a clear chain length-dependent influence on the viscosity of both the neat ILs and their corresponding blends with silicone oil. Importantly, ILs with longer alkyl chains demonstrated superior thermal stability and sustained miscibility even at elevated concentrations. Collectively, these findings underscore the pivotal role of alkyl chain length and anion type in modulating the physicochemical behavior of silicon-based ILs, thereby offering valuable insights into their prospective use in lubricant formulations.

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Identification and Mechanistic Study of 2-oxo-1,2-dihydroquinoline-3-carboxamide Derivatives as Potent Anticancer Agents

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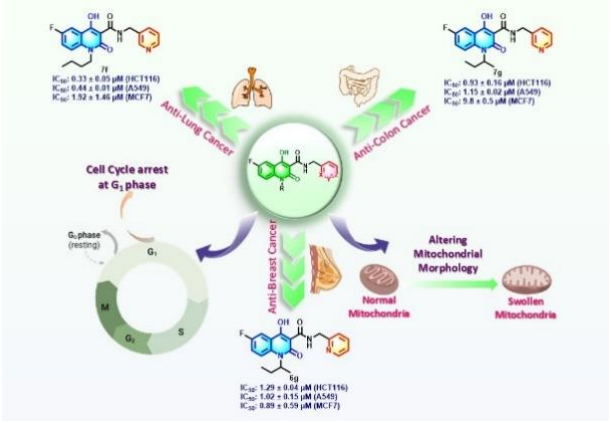
Despite substantial advancements in cancer therapy in recent years, there is a major unmet need for more effective treatments. The therapeutic potency of 1,2-dihydro-4-hydroxy-2-oxoquinoline compounds has been shown by developing the potential anticancer agents Roquinimex and Tasquinimod [1,2]. The present investigation designed a series of twenty-eight 1,2-dihydro-4-hydroxy-2-oxoquinoline-3-carboxamide derivatives by considering Tasquinimod as a lead molecule. The synthesis was achieved through a four-step synthetic route from 5-flouroisatin. Cytotoxicity effects of the synthesized molecules on A549 (lung carcinoma), HCT116 (colon carcinoma), MCF7 (breast carcinoma), and the non-cancerous lung fibroblast cell line MRC-5 were evaluated using the MTT assay. The activity of molecules 7f, 7g, and 6g was promising. It was further investigated using cell cycle analysis, apoptosis assay, DNA damage analysis, mitochondrial membrane potential assay, colony formation and spheroid formation analysis. These studies revealed the ability of 7f, 7g and 6g to induce cell cycle arrest and affect mitochondrial activity. In addition, *in silico* studies revealed the high drug-likeliness properties of these compounds. These molecules' anti-cancer potency and minimal toxicity in the non-cancerous lung fibroblast cell line, MRC-5, and high druggability highlight their selective cytotoxicity towards the tested cancer cell lines, raising the possibility of their development as anti-cancer agents.



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Unveiling the Electrocatalytic Mechanism of Carbonophosphates Towards Water Oxidation Catalysis

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This work employs in-situ X-ray absorption spectroscopy (XANES and EXAFS) measurements to elucidate the local structural and electronic level transformations[1,2] of Co, Ni, and Mn carbonophosphates ($Na_3CoCO_3PO_4$, $Na_3NiCO_3PO_4$, $Na_3MnCO_3PO_4$) during the electrochemical water oxidation reaction (OER). These materials possess sidorenkite-type structures that are well crystallized in the monoclinic framework (*P2₁/m* space group).[2,3] In-situ XANES analysis reveals a characteristic shift in cobalt and nickel K-edges of carbanophosphates during OER conditions. This can be attributed to an increase in their average oxidation states of cobalt and nickel, reaching +2.37 and +2.54 at 1.2 V and 1.4 V (vs. RHE), respectively. This rise aligns with the formation of Co(O)OH and Ni(O)OH, confirmed by Raman spectroscopy. Notably, EXAFS analysis suggests shorter Co-O/Ni-O bonds and stronger Co-Co/Ni-Ni interactions at their respective OER potentials for cobalt and nickel carbonophosphates compared to their pristine counterparts. This indicates the surface transformation from distorted octahedra to crystalline oxyhydroxides with symmetrical metal coordination. Ex-situ analysis of post-OER samples using synchrotron XRD refinement and XPS depth profiling further strengthens the surface reconstruction hypothesis. In conclusion, the catalyst surface undergoes a transformation into oxyhydroxides during OER conditions, leading to enhanced OER performance for cobalt and nickel carbanophosphates.

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A Colorimetric Chemosensor for the Selective Detection Hg^{2+} ions in Semi Aqueous Media: DFT insights and Test Strip Application

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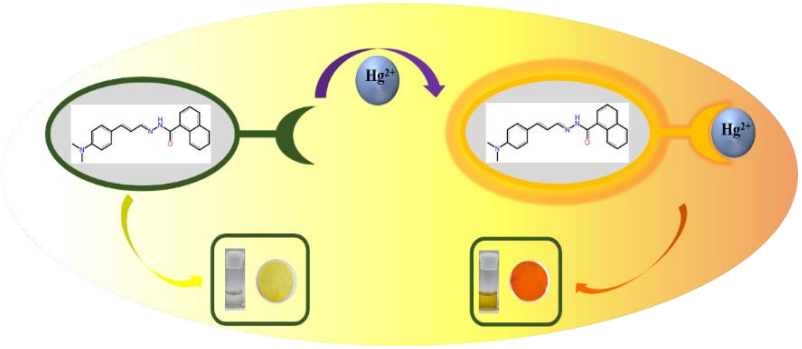
A novel receptor, DMAPAN ((E)-N'-((E)-3-(4-(dimethylamino)phenyl)allylidene)-1-naphthohydrazide) was designed, synthesized, and evaluated as a colorimetric chemosensor for the selective detection of mercuric ions (Hg^{2+}). A semi-aqueous solution of 20% aqueous DMF and buffered at physiological pH (7.2) was used for the sensing investigations to enhance ion selectivity and maximize binding interactions. The receptor exhibited a distinct naked eye detectable colour change from colourless to bright yellow upon interaction with mercuric ions. In contrast, no other tested ions have shown a significant colour change when in contact with DMAPAN, illustrating the high selectivity of DMAPAN toward mercuric ions. The binding interaction between the receptor DMAPAN and mercuric ion investigated using UV-visible spectroscopic titration, where an initial absorption maximum (λ_{max}) at 380 nm underwent a red shift to 452 nm upon Hg^{2+} binding, which is evidenced by DFT study. Hg^{2+} interacts with the imine nitrogen and carbonyl oxygen of DMAPAN, initiating an intramolecular charge transfer (ICT) that results in a bathochromic shift. A Benesi–Hildebrand (B–H) plot analysis revealed a high binding constant, and the limit of detection (LOD) was determined to be remarkably low from the calibration curve. Additionally, test strip applications were carried out, showing an instant colour change upon exposure to Hg^{2+} ions, indicating potential for practical, on-site mercury detection.

Key words: colorimetric sensor, mercury, spectroscopic, application



Pd(II)-catalyzed direct addition of Arylboronic acids to Nitriles in water: Synthesis of Diaryl and Alkyl Aryl Ketones

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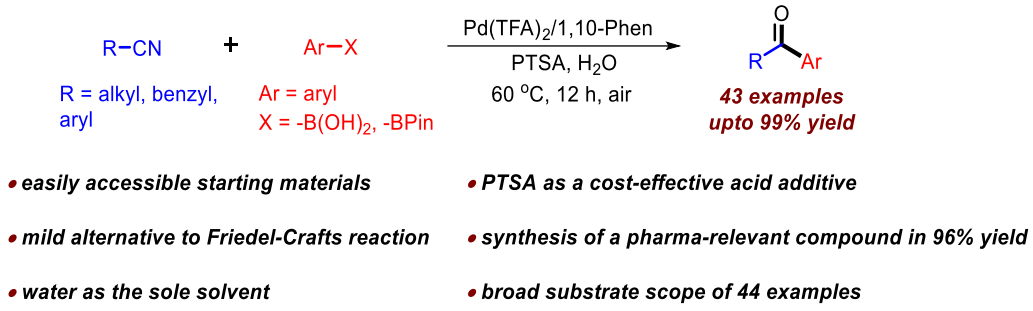
Both diaryl and alkyl aryl ketones, serve as essential intermediates in the synthesis of pharmaceuticals, agrochemicals, and functional materials. A Pd(II)-catalyzed protocol has been developed for the direct synthesis of aryl ketones *via* addition of arylboronic acids (and their ester derivatives) with aromatic as well as aliphatic nitriles. This methodology proceeds under mild conditions**,** utilizing *p*-toluenesulfonic acid (PTSA) as a cost-effective additive and water as the sole solvent, which enhances the sustainability of the process. This method exhibits excellent functional group tolerance and a broad substrate scope, making it suitable for the synthesis both diaryl and alkyl aryl ketones in moderate to excellent yields. The synthetic utility of this approach is further exemplified by the synthesis of a pharmaceutically relevant compound, (4-Methoxyphenyl)(3,4,5-trimethoxyphenyl) methanone (PHT) with an excellent yield of 96%. Gram-scale synthesis of (4-hydroxyphenyl)(*p*-tolyl) methanone (3o) was achieved in 86% yield (1.81 g), demonstrating the protocol's scalability.



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Dihalo- to Carbonate bound bis-NHC-Ni Complexes *via* Methanol Oxidation with Biphenyl based Ligands: Synthesis, Structure, and Spectral Characterization

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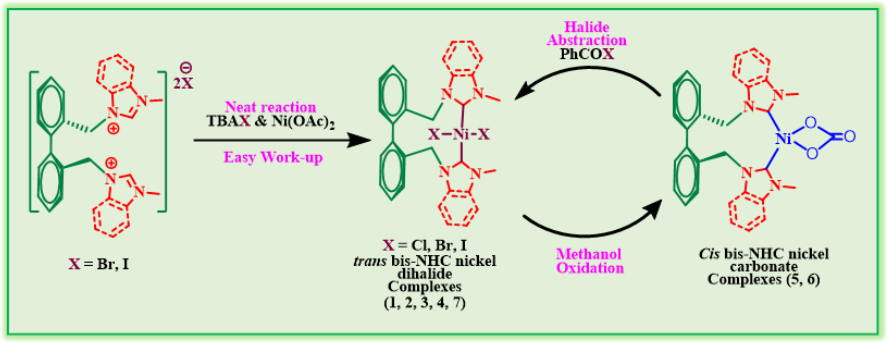
N-heterocyclic carbenes (NHCs) have emerged as one of the most versatile and widely utilized classes of ligands in organometallic chemistry due to their strong σ-donating and weak π-accepting properties. Nickel becomes an interesting alternative to palladium due to its relative low cost, availability and capability to undergo oxidative addition reactions more readily. Herein, we report the synthesis of biphenyl linked imidazolium and benzimidazolium Nickel N-heterocyclic carbene (NHC) complexes [L^1NiBr_2] **1**, [L^1NiI_2] **2**, [L^2NiBr_2] **3**, [L^2NiI_2] **4**. Further, [L^1NiCO_3] **5**, [L^2NiCO_3] **6** were synthesized *via* methanol oxidation with Ag(I) salts as co-catalyst. The complex **6,** when treated with benzoyl chloride resulted in the complex [L^2NiCl_2] **7**. All these complexes (**1–7**) are characterized by NMR, ESI-MS, elemental analysis and SCXRD. The dihalo *trans* complexes **1, 2, 3** & **4** were treated with $AgPF_6$ to form *cis* complexes **5** & **6** in the presence of methanol or dichloromethane/ methanol mixture. When the complex **6** was treated with benzoyl chloride, it abstracts chlorides to produces *trans* bis-NHC nickel-dichloro complex **7.**



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Naphthoic Acid Hydrazide Derivative as Selective Colorimetric Chemodosimeter for Cyanide Ion

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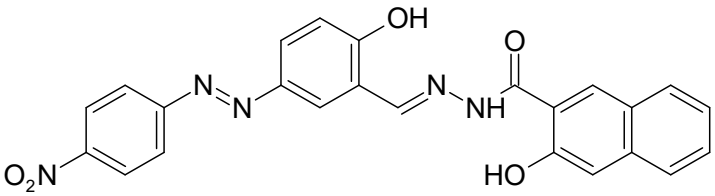
The azo-based chemodosimeter (N'E)-3-hydroxy-N'-(2-hydroxy-5-((4-nitrophenyl) diazenyl) benzylidene)-2-naphthohydrazide (hhnbn) has been prepared and characterized by FT-IR and ^{1}H NMR spectroscopy and ESI-MS spectrometry. Compound hhnbn generates a new absorption band at 510 nm and subsequently, red colour in 7:3 (v/v) water/dimethyl sulphoxide (DMSO) medium in presence of CN^- ion selectively which is visible under naked eye condition. Moreover, Whatman filter paper test strips, previously soaked in hhnbn solution and dried, are found to produce red colour in presence of CN^- ion selectively. Nucleophilic addition reaction of CN^- ion with the imine carbon (CH=N) of hhnbn is corroborated by ^{1}H NMR titration. The functioning of hhnbn with CN^- as chemodosimeter is also validated by ESI-MS data. In addition, hhnbn is capable for using as practical colorimetric probe for the detection of CN^- ion for real-time analysis of water samples.



hhnbn

MOF Derived Bimetallic Selenide for OER and HER Applications

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Hydrogen generation through electrocatalytic water splitting is an efficient method for sustainable hydrogen production. The Hydrogen Evolution Reaction (HER) at the cathode and Oxygen Evolution Reaction (OER) at the anode are the two important processes in electrocatalytic water splitting. Precious metals such as platinum are the state-of-the-art catalysts for the HER, and ruthenium and iridium oxides are the benchmark catalysts for OER. However, their commercialization is limited because of their high cost and rarity. Thus, an electrode with superior catalytic activity and durability in a cost-effective manner is the need of the hour.

Metal–organic frameworks (MOF) have recently attracted interest for HER and OER applications. Herein, MOF-derived bimetallic selenides were synthesized by a two-step hydrothermal synthesis. A cobalt-based MOF, fabricated with benzene tricarboxylic acid as the organic linker, was successfully transformed into a bimetallic bismuth-cobalt (Bi, Co) selenide. The catalyst exhibited excellent bifunctionality towards the OER and HER. An overpotential of 370 mV at a current density of 10 mA cm^{-2} was observed for OER in 1 M KOH, and an overpotential of 300 mV at a current density of 10 mA cm^{-2} was obtained for HER in 0.5 M H_2SO_4.

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Ligand Framework Effects on the Structures of Co(II), Ni(II), and Cu(II) Complexes Derived from Sulfide and Sulfoximine based N,S/N,N- Donor Ligands

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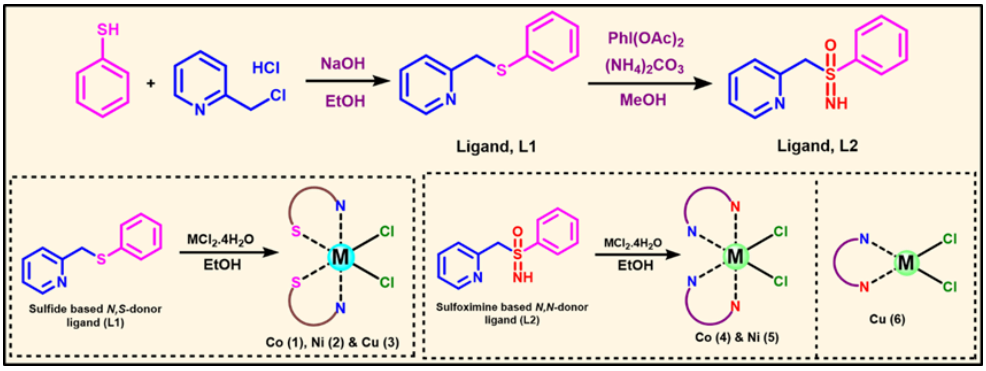
Over the decades, different classes of sulfur and sulfoximine compounds have been described earlier. Transition-metal complexes with sulfide and sulfoximine ligands were generally less investigated. Herein, we report Co(II) 1 & 4, Ni(II) 2 & 5 and Cu(II) 3 & 6 complexes using *N,S*-donor functionalized (L1) and *N,N*-sulfoximine (L2) based ligands. All the complexes were spectrally characterized and structurally determined by SC-XRD. The sulfide based ligand, **L1** was synthesized through known reports. The sulfoximine ligand, L2 was synthesized by imination and oxidation of L1. The *N,S*-donor functionalized complexes 1, 2 & 3 were immobilized on graphene sheets and subjected to electrocatalytic studies which were efficient towards H_2O_2 production *via* 2-electron transfer. The sulfoximine based complexes 4, 5 & 6 were theoretically compared to the sulfide complexes and they were investigated for their electrocatalytic efficiency.



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Fabrication of a Selective and Sensitive Electro-synthesized molecularly imprinted Polymer-based Electrochemical Sensor for the determination of Sleep Hormone

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Molecularly imprinted polymer (MIP)-based electrochemical sensors have always won the attention of researchers due to their predetermined selectivity and high mechanical and chemical stability. MIP was fabricated by electropolymerisation of the functional monomer in presence of analyte, Melatonin (MT) onto the surface of modified glassy carbon electrode (GCE)is reported here. MT is an important electroactive hormone that regulates different physiological actions in the brain, ranging from circadian clock to neurodegeneration.[1]Fabriacted sensor is characterized using Field Emission-Scanning Electron Microscopy and Electron Impedance spectroscopy. Various experimental parameters were optimized to avail maximum performance of the sensor. Under these analytical constraints, the sensor was able to show a wide concentration range with low limit of detection. The mechanistic aspects involved in the electro oxidation of the analyte were studied. It was successfully applied in synthetic physiological fluids in order to verify its practical utility Furthermore, studies to account for the repeatability, reproducibility, and stability of the sensor were carried out.

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Mesopores Copper-Nikel Ferrite Magnetic Nanoparticles (Cu0.5Ni0.5Fe2O4 MNPs) catalyzed one pot Knoevenagel–Michael reaction for synthesis of functionalized 4,4-(arylmethylene)bis(3-methyl-*1H*-pyrazol-5-ol) motifs

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Here, we outline a straightforward, efficient, and environmentally safe method for synthesis of 4,4'-(arylmethylene)bis(3-methyl-1H-pyrazol-5-ol) derivatives via Knoevenagel–Michael reaction using mesoporous Copper-Nikel Ferrite Magnetic Nanoparticles ($Cu_{0.5}Ni_{0.5}Fe_2O_4$ MNPs) as a reusable nano-catalyst in ethanol solvent. The green chemical sol-gel auto-combustion procedure was used to fabricate the nano-catalyst. The BET technique was used to the surface properties analysis, FT-IR and Raman spectroscopy were used to characterize the structure. The products have been obtained in high yields and short reaction times, and the catalyst was successfully recovered by external magnet and reused for seven times without significant decrement of its catalytic activity. The resulting derivatives were well characterized by IR, 1H NMR, 13C NMR and HRMS.

Keywords: Mesopores Copper-Nikel Ferrite, Knoevenagel–Michael reaction, magnetic nanoparticles, nano-catalyst, reusable, sol-gel auto-combustion

Modified-Activated Carbon for Efficient CO_2 Capture

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In this era of hyper-industrialization, CO_2 capture is considered an effective strategy to lower greenhouse gas emissions, combat climate change, and promote sustainable energy solutions. Out of the many suitable sorbents utilized for CO_2 capture, activated carbon (AC) stands out as a cheap and secure candidate. Obtained via pyrolysis of organic matter followed by steam or CO_2 treatment, it possesses not only high surface area and porosity but also high thermal and chemical stability.[1] This makes AC an ideal option for low-cost capture with flexible properties for better CO_2 selectivity.

The excellent CO_2 adsorbance observed in AC can be further enhanced through various modification methods to produce modified activated carbon (mAC). This can be achieved through means such as functionalization using alkali, amines, or acids, and doping using metal or metal salts.[2,3] Modification amplifies the already well-rounded properties of AC, better equips it for CO_2 capture, and introduces more surface area, pores, and electron-rich sites on the AC surface. The current study focuses on mAC-enhanced CO_2 capture, its overall effects on the environment, and the provision of green, low-cost carbon management.

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The construction of Bimetallic MOFs using diverse BDC linkers for the Efficient adsorption of Tetracycline and Ciprofloxacin

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Tetracycline (TC) and ciprofloxacin (CIP) are widely prescribed antibiotics that persist in aquatic systems due to their excretion in unmetabolized forms, posing risks to environmental and human health. Here, we report the design of iron-polyoxovanadate based metal-organic frameworks (MOFs) functionalized with terephthalic acid derivatives (FeV-BDC, FeV-BDC-NH_2, FeV-BDC-NO_2, and FeV-BDC-OH) for the adsorptive removal of TC and CIP. The materials were systematically characterized by TEM, PXRD, BET, FTIR, and zeta potential measurements. Adsorption studies revealed that FeV-BDC-NO_2 exhibited the highest uptake of TC, as described by the Langmuir isotherm model 2.4004 mmol/g, while CIP adsorption followed the Freundlich model with a maximum capacity of 0.9914 mmol/g. The MOFs demonstrated excellent regeneration performance, retaining >90% of their initial capacity after four adsorption-desorption cycles. These findings highlight the role of electron-withdrawing functional groups in enhancing antibiotic-MOFs interactions and establish bimetallic frameworks as sustainable and efficient sorbents for mitigating emerging contaminants in water systems.

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Versatile Zinc Phthalocyanine-Based Probe for Dual-Mode Detection of Biliverdin and Bilirubin

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Zinc phthalocyanines are highly esteemed as chemical sensors due to their remarkable stability, substantial near-infrared absorption, and pronounced fluorescence emission characteristics. This study presents the development of a zinc phthalocyanine substituted with 3-hydroxypyridine (ZnPcPy), which serves as a dual probe for the selective detection of biliverdin and bilirubin.

Fluorescence studies have shown that ZnPcPy is effectively quenched by biliverdin through a static quenching mechanism associated with the inner filter effect. In contrast, its interaction with bilirubin results in a noticeable color change from colorless to pinkish-red, allowing for sensitive colorimetric detection. The probe exhibits low detection limits of 8.60×10^{-8} M for biliverdin and 2.42×10^{-7} M for bilirubin, demonstrating high selectivity against common interfering substances. The practical application of this method was further confirmed through successful testing on artificial physiological samples. These findings emphasize ZnPcPy as a versatile and reliable dual-mode sensor with significant potential for use in biomedical and clinical diagnostic applications.

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Electrochemical and Structural Insights into 3D Tunnel-Structured Li0.44MnO2 as a Cathode for Lithium-Ion Batteries

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Mn-based materials like LiMn2O4 and Li0.44MnO2 are attractive due to Mn abundance, structural polymorphism, and multiple oxidation states. In this work, we investigate tunnel-type Li0.44MnO2 as a cathode for secondary LIBs.

i) $Li_{0.44}MnO_2$ was synthesized via soft chemical ion exchange from $Na_{0.44}MnO_2$, retaining the orthorhombic Pbam tunnel structure. Its redox behaviour was explored through ex-situ XPS, in-situ XRD, and DFT to probe both Mn and O redox activity.[1,2]

ii) A structural transformation from tunnel to cubic spinel was monitored using in-situ XRD, Raman spectroscopy, and TEM, revealing a shift in redox potential during cycling.

iii) To enhance performance, Ti-substituted Li0.44[Mn1-xTix]O2 (x = 0 – 0.56) was synthesized, preserving the orthorhombic structure and rod-like morphology. Ti doping led to improved capacity, with the best composition delivering 128 mAh/g.[3]

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Nanostructured MnO_2 Catalyst for High Performance Rechargeable Zinc-air Batteries

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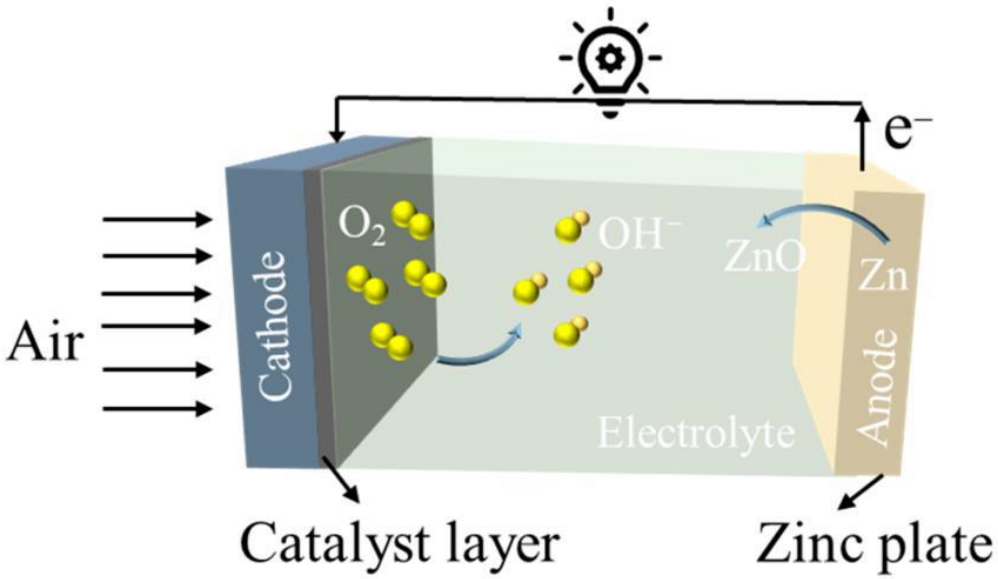
A Zinc-air battery is promising energy storage technology due to their high energy density, low cost, wide availability and environmental friendliness. The theoretical specific energy of zinc–air battery is 1350 Wh kg^{-1}, but its practical specific energy is only about 200 Wh kg^{-1}. Currently, zinc–air batteries are only applied to the fields of hearing aids, navigation lights, and railway signals. However, several challenges such as limited cycle life due to anode degradation, electrolyte stability issues, low efficiency of the oxygen reduction reaction (ORR) at the cathode, and the zinc dendrites formation during charging. To address these issues, a facile room-temperature synthesis method has been successfully developed to produce nanostructured Manganese dioxide (MnO_2) via a simple precipitation method. Characterization techniques such as X-ray diffraction (XRD) and Scanning electron microscopy (SEM) were used to analyze the structure, morphology, and particle size of the synthesized MnO_2 catalyst. Electrochemical tests, including cyclic voltammetry and galvanostatic charge-discharge studies were conducted to evaluate the Manganese dioxide performance in rechargeable zinc-air batteries. The detailed results will be discussed during presentation.



P2-type layered Oxide Materials for Potassium-Ion Batteries

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The high demand for Li-ion batteries in energy storage applications, along with their growing cost, has accelerated the search for cost-effective alternatives. Potassium-ion batteries (KIBs) offer comparable energy density, cycling stability, and power density.[1] Among various cathode materials, P2-type layered materials exhibit greater ionic diffusivity. However, synthesizing P2-type compounds poses challenges due to their metastable nature, as indicated by density functional theory (DFT) calculations. While electrochemical synthesis methods have been explored in previous studies, these approaches are often complex and unsuitable for producing bulk materials. To address these challenges, we employed a soft chemistry approach via the ion-exchange method to produce three P2-type structured compounds for KIBs.[2] Analytical techniques like X-ray diffraction (XRD), inductively coupled plasma (ICP) analysis, Fourier-transform infrared spectroscopy (FTIR), and Raman spectroscopy were utilized to investigate the local coordination environment and crystal structure of the synthesized materials. The materials were then tested in half-cell configurations, demonstrating decent capacity and stable electrochemical performance. Our work offers insights into the synthesis of metastable P2-type layered oxide for potassium-ion batteries, which are challenging to obtain through direct calcination methods.[3] These findings highlight the potential of soft chemistry routes for developing next-generation cathode materials for practical potassium-ion batteries.

Keywords: Potassium-ion batteries, Cathodes, Layered oxides, *Chime Douce*, Ion exchange

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Molybdate and Tungstate Alluaudite-type Anode Materials for Sodium-Ion Batteries

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Alluaudite-type mineral frameworks are applicable as electrode materials in rechargeable batteries.[1] These three-dimensional structures with wide one-dimensional hexagonal tunnels permit facile migration of alkali ions, enhancing their suitability for rechargeable batteries. Their general expression, $A(1)A(2)M(1)M(2)_2(XO_4)_3$, hosts alkali (A) and transition-metal (M) cations, with X = S, B, Si, P, As, Mo, W and V.[2] The polyanionic tetrahedra (XO_4) impart structural robustness and high working voltage via the inductive influence. More electronegative X produces stronger covalent bonding with oxygen, consequently making TM–O interaction more ionic and achieving an elevated ($Mn+1/Mn^+$) redox potential.[3] Current investigations on orthophosphate- and sulfate-based alluaudites demonstrate their promise as cathodes for Li-ion and Na-ion cells.[4] Broadening this family, a molybdate alluaudite $Na_{2.67}Mn_{1.67}(MoO_4)_3$ was reported as a 3.45 V cathode employing Mn and Mo redox couples.[5]

In our research, we explored Cu-molybdate analogue $Na_2+2xCu_{2-x}(MoO_4)_3$ as prospective anode material for rechargeable Na-ion batteries. We prepared this composition initially using the solution combustion method. This molybdate alluaudite exhibited electrochemical reactivity at reduced potential regions, employing Cu and Mo as active redox species. The structure, redox mechanism, electrochemical behaviour and magnetic responses of these MoO_4-alluaudites will be examined through diverse analytical approaches. Afterwards, $Na_2+2xMn_{2-x}(WO_4)_3$ will be introduced as a fresh tungstate alluaudite serving as an anode in Na-ion batteries. This investigation underlines the versatility of alluaudite architectures for discovering innovative battery electrode chemistries.

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Tailoring Electrolytes to Boost Room Temperature Sodium-Sulfur Battery Longevity and Capacity

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Due to their high specific energies, low cost and high theoretical energy density, metal-sulfur batteries such as Li-S, Na-S, and Mg-S batteries are particularly appealing among other cutting-edge energy storage technologies. Room-temperature sodium–sulfur battery is considered to be a promising candidate for next-generation batteries due to its high theoretical energy density (~1270 Wh kg−1) because they use a two electron redox mechanism to produce large store capacity from low cost electrode material. This system is still in its early stages of research, and it is facing significant obstacles because to its lowionic conductivity, short cycle life, large volume change, rapid dendrite growth, and high chemical reactivity. Furthermore, because of the multi-step reactions and the creation of different polysulfides, the reaction mechanism of S with Na ions varies depending on the electrolyte that is used and is extremely complex and challenging to detect. In sodium-sulfur batteries, this bilateral SEI technique has been used to stop polysulfide shuttle and dendritic development. In order to facilitate the formation of bilateral solid electrolyte interphase (SEI), we investigated a variety of electrolyte compositions. Specifically, organic solvents such as PC, EC, FEC and TEGDMEwere combinedwith NaTFSI and NaClO4saltsalong with NaNO3in different proportions to make electrolyte solvents that contained both ethers and carbonates.And also we synthesis pristinesulfur with a small particle size in solution based method. TheNa2S2O3·5H2O was dissolved in the deionized water by magnetic stirring, followed by the addition of10 M HCl. The above mixture was stirred for 24 h at room temperature. Then the sulfur product was filtered anddried in an air oven at 50 °C for 24 h.Physical characterization for sulfur material andElectrochemical studies such as CV, EIS and galvanostatic charge-discharge were conducted to evaluate the performance.

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Tailoring Electrolytes to Boost Room Temperature Sodium-Sulfur Battery Longevity and Capacity

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An Improved Step-Up Converter Design for Metal-Air Battery Lighting System

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Metal-air batteries have emerged as a promising and sustainable energy solution, particularly for off-grid applications such as rural or remote area lighting. These batteries offer several advantages, including their relatively high energy density and environmental friendliness, making them ideal candidates for powering devices in areas with limited access to conventional electrical grids. One of the most demanding applications of metal-air batteries is in LED lighting systems, which are known for their ecofriendlyness and long shell life. However, despite their potential, the integration of metal-air batteries into these systems presents a critical challenge of voltage mismatch between the low output of the metal-air battery and the voltage requirements of the LED lighting. Metal-air batteries typically provide a low output voltage, which may not meet the operating requirements of LEDs, which typically require a stable, higher voltage to function effectively. This voltage discrepancy makes it essential to incorporate a step-up converter to convert the low battery voltage into the necessary higher voltage required by the LED. The efficiency and reliability of this converter play a critical role in ensuring the longevity and performance of the lighting system. Therefore, the design of the step-up converter is of paramount importance in maximizing the potential of metal-air batteries. This paper proposes a step-up converter specifically designed to address the challenges presented by metal-air battery-powered lighting systems. The converter design aims to provide stable voltage regulation, ensuring that the LED lighting system operates reliably over extended periods.This work represents a significant contribution to the development of off-grid lighting solutions and paves the way for the successful integration of metal-air batteries into LED-based lighting systems and promises for providing a sustainable and affordable source of lighting for off-grid communities, thereby contributing to global efforts aimed at improving access to clean energy in underserved regions.

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An Improved Step-Up Converter Design for Metal-Air Battery Lighting System

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$Ni_{0.5}S$-$Cu_{0.5}S$ Composite Cathode: A Synergistic Approach to High-Performance Seawater Batteries and Self-Sustained Hydrogen Generation

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Integrating energy storage with clean hydrogen generation from seawater is pivotal for advancing sustainable marine energy systems.[1,2] This study presents a self-supported cathode comprising nickel sulfide-copper sulfide ($Ni_{0.5}S$–$Cu_{0.5}S$) nanocomposites, directly synthesized on a carbon fiber brush (CFB) substrate. The synergistic combination of NiS and CuS enhances electrical conductivity, structural integrity, and catalytic activity under harsh saline conditions. The $Ni_{0.5}S$-$Cu_{0.5}S$@CFB electrode demonstrates exceptional hydrogen evolution reaction (HER) performance in seawater, requiring an overpotential of only 198 mV to achieve a current density of −10 mA cm^{-2}, with a Tafel slope of 68 mV dec^{-1}.

When employed in a magnesium–seawater battery configuration, the modified cathode supports continuous discharge for over 30 hours, exhibiting stable voltage profiles and high corrosion resistance. The system maintains robust performance across variable natural seawater conditions, including changes in pH and salinity. This work establishes a cost-effective, durable, and bifunctional cathode platform for simultaneous seawater battery operation and green hydrogen production, advancing the development of self-powered marine energy systems.

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Advancing Bone Implant Technology Through Multi-Beam Laser Interference Lithography

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Multi-beam Laser Interference Lithography (MBLIL) is a flexible, mask-free method of nanostructuring that has shown great promise for biomedical use, particularly in the field of bone implants. The approach relies on the interference of several coherent laser beams to produce well-organized surface patterns, where the feature size can be tuned at both micro and nano scales. By modifying parameters such as wavelength, beam incidence angle, and the number of beams, the technique allows accurate adjustment of fringe spacing, surface geometry, and periodic structures. For bone implant engineering, creating specific surface textures is vital to improve biocompatibility, encourage osseointegration, and reduce implant failure. Surfaces engineered with MBLIL can replicate the multi-scale structure of natural bone, strengthening the mechanical bond with host tissue while guiding cell attachment, growth, and differentiation. Moreover, the method supports fabrication of varied geometries including grid-like, hexagonal, and quasi-periodic designs making it possible to design implants tailored to anatomical needs.

MATLAB simulations demonstrate the versatility of MBLIL in generating distinct interference patterns with varying beam parameters and depth of focus, enabling optimized implant surface design prior to fabrication. In summary, MBLIL offers a scalable, cost-effective, and reproducible pathway for producing biofunctional implant surfaces. Its adaptability makes it a promising technology for advancing implant design and supporting innovations in regenerative medicine.

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Assessment of Sediment Yield in Chalakkudy River Basin, India using SWAT Model

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Understanding the sediment yield of a watershed is crutial in effective water resource management, river morphological change detection and flood prediction especilally in regions that experience drastic changes in its rainfall pattern. This study is aimed to evaluate the capability of SWAT model to predict monthly sediment yield of Chalakkudy River Basin, Kerala and the effects of subbasin delineation on this prediction. The ArcSWAT interface in ArcGIS software was used to define the study region and sub-components, merge data layers, and change model database. SUFI-2, a SWAT CUP2012 application, was used to optimize sediment parameters utilizing observed data from the watershed. The model was calibrated from 1993 to 2012 and then validated from 2013 to 2022. The evaluation shows good performance during calibration and validation, with reasonable agreement between measured and simulated values for monthly based sediment data on three specified statistical coefficients namely NSE,R^2 and PBIAS. The average sediment yield of Chalakkudy river basin was found to be 79.9 Mg/ha and the maximum sediment yield was found in subbasin 11 with a value of 494.95 Mg/ha.The calibrated model can be applied to any ungauged watersheds with similar topography, land use, soil, and climate to assess the erosion and adopt optimum management options globally.

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Bio-Inspired Pneumatic Locomotion System for Terrain-Adaptive Robots

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This work proposes a bio-inspired pneumatic actuator system designed to aid locomotion in paralysed individuals by replicating the contraction–relaxation mechanisms of natural muscles. Drawing inspiration from soft-bodied organisms such as worms and caterpillars, which achieve movement through sequential peristaltic contractions, the system employs Pneumatic Artificial Muscles (PAMs) integrated at human joints to generate controlled motion.

Unlike conventional motor-driven exoskeletons that are rigid, bulky, and costly, the proposed design emphasizes softness, compliance, and lightweight architecture. Silicone-based PAMs mimic muscle fibres by contracting under air pressure and relaxing when deflated, thereby offering lifelike joint motion. The system is intended to be modular, wearable, and customizable for lower-limb rehabilitation.

A dual control approach is envisioned: (i) microcontroller-based actuation with sensor feedback to regulate pressure and timing, and (ii) simplified pneumatic logic circuits for low-cost, electronics-minimal operation. Preliminary design studies suggest that this approach can restore partial mobility while reducing weight, complexity, and cost compared to existing assistive devices.

This project aims to bridge the gap between biomechanics and fluid power by translating natural locomotion strategies into human-assistive technology. Its long-term vision is to provide a safe, affordable, and effective rehabilitation tool for patients with motor impairments.

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Smart Agriculture: Comparative Study on Automated Lemon Spot Grading with Lightweight Fast Learning Methods.

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Although India is one of the leading lemon-producing countries in the world, significant post-harvest losses caused by manual grading and handling practices have led to significant reduction in exports. The quality of lemons is largely influenced by attributes such as size, color, and texture. Traditionally, this evaluation is carried out through manual grading, which is both effort-intensive and susceptible to human errors, often leading to inconsistencies in quality assessment. An Intelligent lemon grading system with object detection and quality classification can resolve the problems. This paper aims to compare various light weight fast learning models for real time on spot grading of lemons into quality-based classes. The models employed for comparative analysis involves the lightweight fast models such as YOLOv8 (You Only Look Once - version 8), CNN, integrated approach combining YOLOv8-based object detection and ResNet18 – CNN-based lemon classification. The models used for the comparative study were trained on a self-created dataset and validated in real time using the Intel RealSense D435 depth camera

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Intra-household Disparity Sensitive Fuzzy Multi-Dimensional Vulnerability Index: A Study of Construction and Decomposition through Artificial Intelligence

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Within poverty studies the concept of economic vulnerability is gaining importance. This work is mainly concentrated around estimation and decomposition of ex-ante multidimensional economic vulnerability with the help of artificial intelligence using fuzzy logic. The possibility to become poor in future is termed here as vulnerability. It is observed within existing studies that when vulnerability has been defined as ex-ante, it is not defined within fuzzy framework; when it is defined through fuzzy membership function it is not applied to the multi-dimensional poverty; when these are applied to ex-post poverty determination, the ex-ante world has been left untouched. When importance of intra-household sensitive multi-dimensional poverty has been discussed, the same has not been discussed within the ambit of fuzzy ex-ante multi-dimensional framework. Thus, the contribution of this study lies in the application of fuzzy membership function with the help of artificial intelligence in the determination of intra-household disparity sensitive ex-ante multi-dimensional poverty measure. As this work has tried to incorporate the within household vulnerabilities within the composite measure of multi-dimensional vulnerability this work has decomposed the constructed measure to understand the influences of inter and intra household vulnerabilities. Apart from developing conceptual idea this work has developed detailed mathematical model to construct and decompose the fuzzy multi-dimensional vulnerability scores. This mathematical model is implemented with the help of secondary as well as primary data within the framework of artificial intelligence. It is found that the impact of the intra-household factor is 8 percent (rounded-off) of the composite multi-dimensional social vulnerability whereas the inter-household impact on composite multi-dimensional social vulnerability is 92 percent (rounded-off). So, most significantly, it is the decomposition of composite vulnerability which has challenged the existing international structure of System of National Account (SNA) through establishing the fact that the intra household factors are not ignorable in the studies of national accounts. In other words, the most important finding of this study is - apart from developing a composite measure of vulnerability, that the existing international system of composite social measurement of national accounts is not flawless and ignored intra-household disparities to a large extent.

Value added Composite Panel from Natural Fiber and Waste expanded Polystyrene

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Expanded polystyrene (Thermocol) used in all packaging industries due to its shock absorption and insulation properties. However, expanded polystyrene (EPS) poses serious environmental challenges as it is not easily degradable and storage is an issue for the same due to its large volume and recyclability. The main aim of this research work is to produce composite panels from waste materials EPS and coconut fiber with varying proportion of both constituents for better mechanical and physical properties of composite. Composite panel were produced by combining coconut as a fiber and matrix derived from EPS waste based on a weight percentage using compression molding method. Four different coconut fiber-to-EPS adhesive rations-40:60, 50:50, 60:40, and 70:30 were selected to produce the composite panel. Mechanical, water absorption and thermal stability tests were conducted on all prepared composite panel to evaluate their performance. Composite panels were pressed under compression molding machine at high temperature with a constant pressure for 2 hrs for better. The findings of this study showed that waste packaging materials such as EPS can be used as raw materials for value-added composite production. Such utilization of waste packaging materials and EPS for composite panels has a significant influence with high ecological impact which leads towards sustainability solution.

Probing Reionization with 21-cm Signal: Enhancing Inference Using Machine Learning and Higher-Order Statistics

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The redshifted 21-cm line of neutral hydrogen (HI) offers a unique probe of the early universe, particularly during the Cosmic Dark Ages and the Epoch of Reionization (EoR). However, the intrinsic 21-cm signal is extremely faint and heavily contaminated by foreground emissions from bright astrophysical sources. To overcome these challenges, we rely on statistical fluctuations of the 21-cm signal to infer the underlying astrophysical and cosmological parameters. In this study, we employ machine learning techniques to efficiently generate a large suite of simulations and perform Markov Chain Monte Carlo (MCMC) sampling to constrain the neutral hydrogen fraction. Although traditional analysis often rely on first-order statistics, such as the power spectrum, these are insufficient to capture the full information content of the signal. We demonstrate that incorporating higher-order statistics(bispectrum) significantly enhances the precision of parameter estimation and improves our understanding of the reionization process.

Direct growth of Vanadium-Incorporated CoxSy Nanopyramids on Conducting Substrates: A facile approach for enhanced Alkaline Hydrogen evolution reaction

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Developing efficient and cost-effective electrocatalysts for hydrogen evolution reaction (HER) in alkaline media is vital for large-scale hydrogen production. Cobalt sulfides (Co_xS_y) show promise as HER catalysts, but their activity remains still insufficient. Nanostructures with sharp edges are known to enhance H^+ adsorption during HER, but the production of such morphologies and additional dopant incorporation require multi-step processes. Here, we developed a one-step hydrothermal method that simultaneously incorporates vanadium into cobalt sulfide nanopyramids (*i.e.*, V: Co_xS_y), with pointed tip morphology, which ensures synthesis scalability. Vanadium, with lower electronegativity and a smaller ionic radius than cobalt, modifies the catalyst's electronic and adsorption properties. The V: Co_xS_y nanopyramids grown on carbon cloth were used as binder-free electrodes for HER in 1 M KOH, demonstrating superior HER performance with an overpotential of 200 mV at 10 mA/cm² and a Tafel slope of 95 mV/dec, coming close to the Tafel slope of the benchmark Pt/C catalyst.

Keywords: Co_xS_y nanopyramids, Vanadium incorporation, Electrocatalyst, Self-standing electrode, Hydrogen evolution reaction.

Leaning from Fully Supervised to Self-Supervised Learning in Medical Imaging

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Deep learning models trained with full supervision have become the standard for multiple domains including medical imaging, achieving impressive results in applications such as skin cancer detection. These models, however, require large amounts of data that have been carefully labeled by medical experts which can be expensive and time consuming to obtain. Additionally, supervised models sometimes learn to rely on irrelevant features in the images, such as background textures or imaging artifacts, rather than focusing on the actual areas of clinical interest. We demonstrate this problem by using Class Activation Maps (CAMs), which visualize the regions of an image that a model uses to make its predictions. We found that supervised models often highlight non-relevant regions, raising concerns about their reliability and suitability for real-world medical use. To overcome these limitations, we explore Self-Supervised Learning (SSL), a technique that allows models to learn useful and robust features from large collections of unlabeled images. We further show how SSL can help create models that are more reliable, generalizable, and better aligned with the needs of clinicians and patients.

Exploring the Dark Ages Using 21-cm Cosmology

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The Dark Ages represent an important period in the evolution history of the Universe. It provides an opportunity to study fundamental cosmology, similar to the Cosmic Microwave Background (CMB) as this era was unaffected by astrophysical processes. This contrasts with modern cosmological probes, like those based on galaxy distribution or Lyman-alpha absorption lines which are inherently limited by uncertainties stemming from complex astrophysical phenomena like star formation, radiative feedback, and supernova-driven effects. The redshifted HI 21-cm signal is a promising if not the only probe of the Dark Ages. The signal can be observed either by measuring the sky-averaged global signal or by analyzing fluctuations across different length scales. Unlike the CMB, which represents a snapshot from a single cosmic time, the 21-cm signal spans a range of cosmic times, offering a 3D view of the Universe. Furthermore, the 21-cm power spectrum retains small-scale fluctuations that are smoothed out in the CMB, enabling it to reveal a greater wealth of cosmological information. Additionally, the Dark Ages provide a framework for studying unconventional cosmological models, such as dark matter-baryon interactions or anomalies in the primordial power spectrum. The 21-cm signal is also considered a promising tool for probing primordial non-Gaussianity at levels consistent with predictions from cosmic inflation. This study aims to advance precision cosmology and uncover new aspects of fundamental physics by setting the stage for future lunar and space-based experiments.

Structural, Morphological and Magnetic Properties of CoNiW Thin Films Prepared by Potentiostatic Electrodeposition

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The precise control over the synthesis parameters can facilitate the properties of CoNiW thin films, particularly magnetic properties. Understanding the correlation between structural and magnetic properties of CoNiW thin films holds the key for realization of their applications. In this research, the CoNiW thin films were prepared on copper (Cu) substrate by potentiostatic electrodeposition. The preparative parameters of electrodeposition were optimized from CV and CA studies. The influence of deposition time and post annealing, on structural, morphological, and magnetic properties of CoNiW thin films were studied. The prepared thin films were characterized by X-ray Diffraction (XRD), Field Emission Scanning Electron Microscopy (FESEM) with Energy Dispersive Spectroscopy (EDS) and Vibrating Sample Magnetometer (VSM). The current kinetics of CoNiW thin films revealed the instantaneous and diffusion-controlled growth. The XPS spectra and EDS studies revealed the presence of Co, Ni, W elements in thin film. FESEM images showed the fine, compact, and uniform grains. The magnetic properties of thin films were investigated from VSM, by studying the effect of different sample orientations as parallel, 45°, and perpendicular. The hysteresis loops obtained from the VSM, confirmed the soft ferromagnetic nature of the films. The film deposited for 90 min and annealed at 200 °C for 1 hour, exhibited the lowest coercivity of 85.62 Gauss than that of as-deposited film (103.94 Gauss) deposited for the same time, with increased saturation magnetization measured across all orientations. The research work confirms that the CoNiW thin films shows predominantly in-plane (parallel) magnetic anisotropy compared to 45°, and out-of-plane (perpendicular) anisotropy which is suitable for magnetic sensor applications.

Keywords: CoNiW thin films; Electrodeposition; Nucleation and growth current kinetics; Magnetic properties.

Sol-gel synthesis of PZT Microtubes

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Lead zirconate titanate (PZT) is a piezoelectric material that exhibits excellent piezoelectric and ferroelectric properties. PZT microtubes are now receiving significant attention for various applications such as sensors, actuators, and energy harvesters. PZT microtubes are often synthesized using a sacrificial template, which involves complex steps to remove the parent template. Herein, we introduce an alternative approach for synthesizing PZT microtubes utilizing a bio-template. The structural characteristics of PZT microtubes are analyzed using x-ray diffraction and Raman spectroscopy, while the hollow tubular morphology is confirmed using FESEM analysis. This study demonstrates that bio-templating is a better alternative for synthesizing PZT hollow microtubes, as it avoids the necessity of removing the parent template from the synthesized microtubes.

Investigations on Morphological Evolution in Tellurium Nanostructures

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Tellurium nanostructures (TeNs) interact exclusively via van der Waals forces and exhibit a quasi-one-dimensional electronic band structure, yielding properties that differ markedly from bulk Tellurium (Te). Here, we report a facile, one-step, room-temperature wet-chemical synthesis of TeNs and systematically examine their morphological evolution. Building on Rani et al.[1] observation that Mo additives induce time-dependent phase transitions in Te nanotubes at 120 °C (and thermodynamic insights by Sudheer et al.[2]), we extended the investigation by varying the reaction temperature (ambient to 135 °C) and reaction time. Using field-emission SEM and high-resolution TEM, we found that at 120 °C Te initially forms nanotubes which convert into nanoflakes after 6 h and then revert in consistent with findings of Rani et al.[1]'s report. At 135 °C, however, the intermediate flake stage is entirely suppressed, and Te nucleates and grows directly as uniform one-dimensional nanorods. FTIR, XRD, and XPS analyses confirm that at 120 °C Mo–O–Te–O and Te–Mo–Te linkages form selectively at 6 h, whereas at 135 °C full reduction proceeds without intermediate bonding rearrangements. EDX shows higher elemental Te content at 135 °C, and thermal conductivity measurements reveal that the nanorods possess enhanced thermal stability. This work thus introduces a novel, solution-based route to stable Te nanorods with improved structural and thermal properties.

Controlled Growth and Characterization of CVD Grown *β*-Gallium Oxide Thin Film for Deep UV Photodetector Applications

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Photodetectors (PDs) are increasingly vital for a range of modern applications, including military surveillance, automated systems, and machine vision. While wide-bandgap semiconductors like gallium oxide (Ga_2O_3) are promising for ultraviolet (UV) detection, existing low-dimensional devices often face challenges such as complex fabrication and suboptimal performance. In this present study we have demonstrate the optimization of growth parameters of *β*-Ga_2O_3 through chemical vapor deposition (CVD) deposited over a SiO_2 and Al_2O_3 substrates. For the growth of *β*-Ga_2O_3 gallium oxide and carbon powders were used. From the structural analysis using X-ray diffraction (XRD) confirms the successful formation of monoclinic *β*-Ga_2O_3. Surface morphology was analyzed using field emission scanning electron microscope (FESEM) revealed the formation of *β*-Ga_2O_3 nanowires (NWs) through vapor-liquid-solid (VLS) growth mechanism. The average diameter of the NWs was ranging from ~ 80 nm to ~ 150 nm and confirms the uniform film formation. The formation of NWs is mainly driven by VLS growth mechanism and promotes the epitaxial growth of *β*-Ga_2O_3. The Raman spectra reveals the presence of both mid and high frequency vibration modes of the *β*-Ga_2O_3. The results of this study demonstrate that CVD growth is a highly promising approach for producing high-quality *β*-Ga_2O_3 films on both SiO_2 and sapphire substrates, offering a fast growth rate and superior material properties essential for advanced PD applications.

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Graphene Quantum Dot-Based Nanofluids: A Novel Approach to High-Performance Thermal Management

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Heat transfer systems are vital components of energy generation technologies, viz., power plants, solar thermal systems, etc. The efficiency of these energy generation technologies depends on the performance of heat transfer system and the properties of fluids used therein for the same purpose. Recently, efforts have been made to improve the thermal properties of fluids by adding nanoparticles. In the present work, a novel shell and tube heat transfer system has been indigenously designed and developed for studying heat transfer properties of nanofluids, and as a case study, graphene quantum dot-based nanofluids have been prepared, and their performance in the said system has been investigated. The effect of process parameters, including concentration of graphene quantum dots, flow rate, temperature gradient between hot and cold fluids, etc., on the heat transfer efficiency of the nanofluids was studied. The system allows to control and optimization of process parameters for the highest heat transfer efficiency. The findings of this study indicate an enhancement in heat transfer coefficient of nanofluids 1507 W/m² °C at a 0.4 wt% graphene quantum dots concentration. The heat transfer effectiveness decreases with increasing flow rate and higher concentration of graphene quantum dots. The thermal efficiency of cold side fluid consistently follows an increasing trend, indicating the thermal performance enhancement, particularly significant at the inlet temperatures of nanofluids 60 °C and 80 °C.

Keywords: Graphene Quantum Dot, Nanofluids, Shell and Tube Heat Exchanger, Heat Transfer coefficient, Thermal Efficiency, Effectiveness

Influence of Film Thickness and Sliding Frequency on the Performance of PVA-Based Triboelectric Nanogenerator

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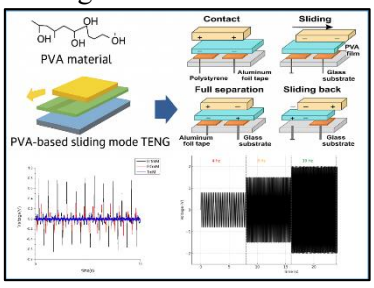
Triboelectric nanogenerators (TENGs) have emerged as promising energy harvesting devices that convert mechanical energy into electrical energy through the coupling of triboelectric effect and electrostatic induction. Their lightweight nature, material versatility, and potential for low-cost fabrication make them ideal for powering small electronics and sensors, particularly in wearable and portable systems. In this study, we report the design and performance evaluation of a sliding-mode TENG utilizing polyvinyl alcohol (PVA) as the active triboelectric layer. The device was constructed in a planar sliding configuration using a tribo-pair of PVA and polystyrene, and its performance was investigated using a home-built, low-cost setup. To evaluate the impact of film thickness, PVA layers were prepared from different molar concentrations. An inverse relationship was observed between PVA thickness and output voltage: a maximum output of 800 mV was obtained for 0.1 mM PVA, while 0.5 mM and 1 mM yielded 300 mV and 100 mV, respectively. These results underline the critical influence of surface morphology and charge accumulation on triboelectric output. Further, a frequency-dependent study was carried out using the optimized 0.1 mM PVA-based device. Voltage-time analysis under variable sliding frequencies revealed that output performance increases with frequency, reaching up to 2 V at 10 Hz. This frequency sensitivity highlights the potential of such TENGs in vibrational and human-motion-based energy harvesting applications. The simplicity of the fabrication method and the use of accessible materials make this TENG design a scalable and cost-effective solution for sustainable energy research and small-scale power generation.

Keywords: Triboelectric nanogenerator (TENG); polyvinyl alcohol (PVA); polystyrene; molarity variation; sliding frequency; energy harvesting.



Effect of Mg Doping on β-Ga_2O_3 Nanostructures for Photocatalytic activity

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This study highlights β-Ga_2O_3 as one of the potential photocatalytic materials whose performance can be enhanced by Magnesium (Mg) doping. An attempt has been made on Mg doped β-Ga_2O_3 as it is a less explored material. Pure (PG) and Mg doped (1 mol% - MG1 and 3 mol% - MG3) β-Ga_2O_3 nanostructures were synthesized using hydrothermal method followed by high temperature annealing. Formation of monoclinic structure was confirmed using X-Ray Diffraction (XRD) analysis. The effect of doping on the crystal structure was also observed in X-ray diffraction plot. Phase purity of the samples was confirmed by Fourier Transform Infrared Spectroscope (FT-IR) with the help of vibrational bands. Morphological analysis showed a cocoon like structure in pure sample. It also revealed a unique morphological transformation of β-Ga_2O_3 upon doping with Mg as shown in Figure 1. Presence of Ga, O and Mg elements were confirmed by Energy Dispersive X-Ray Analysis (EDAX). Optical properties of the samples were studied using UV-Visible and Photoluminescence spectroscopes. To understand the effect of Mg doping on the photocatalytic activity of β-Ga_2O_3, all the samples were tested for degradation of a model dye pollutant, Rhodamine B, owing to its widespread use. It was observed that the doping has significantly improved the photocatalytic activity as shown in Figure 2. The enhancement of photocatalytic efficiency upon Mg doping has been well justified by the characterization tools.

Figure1. Morphology

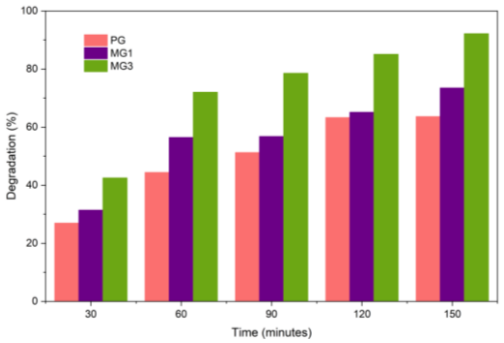

Figure 2. Degradation v*ersus* Time

Electronic structure modulation of AlN_4 single-atom Catalyst for Oxygen Reduction reaction

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Oxygen reduction reaction (ORR) is crucial for the commercial success of environmentally benign energy conversion devices such as fuel cells and metal-air batteries [1]. Replacement of Pt-based and transition metal-based electrocatalyst with efficient non-precious ORR catalysts is quite challenging so for. Single atom catalysts (SACs) based on first-row transition metals like Fe, Co, Cr has already received significant attention for ORR [2]. In this hunt, we have developed the rarely explored P-block aluminium based efficient and cost-effective ORR single atom catalyst. Nitrogen doped Aluminium-based single atom catalyst has been synthesise by pyrolyzing aluminium phthalocyanine (AlPc) with dicyandiamide (DCDA) at different temperature named as Al-N_4-C/T (T = 700 °C - 1000 °C). The catalytic activity of Al-N_4-C/T (T = 700 °C - 1000 °C) has been improved significantly than that of AlPc. N-bonded Al atoms have optimal bonding strength with intermediate oxygen species. The co-ordination environment of Al-N_4-C plays very essential role in exhibiting the excellent catalytic activity towards ORR. The Al-N_4-C/1000 catalyst exhibits highest diffusion limited current (6.5 mA/cm_2) as compared to all other Al-N_4-C/T (T = 700, 800 and 900 °C) based catalysts, along with more positive E_{onset} (844 mV vs RHE) and half wave potential $E_{1/2}$ (749 mV vs RHE). Electrochemical calculation further ropes the Al-N_4 sites as the origin of ORR via efficient 4-electron transfer pathway in basic medium. Importantly, negligible reduction in current density after 9000 cycles in alkaline medium which far superior to the durability limit set by the US department of energy. This methodology can be applied to design a variety of other alkaline earth, P block and transition metal-based effective M-N-C electrocatalysts.

Keywords: ORR; Al-N-C electrocatalyst; SAC; P-block; Excellent stability

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Seasonal and Long-Term Variations in Aerosol Optical Depth and Fine Mode Fraction across Different Regions of India during 2003-2020

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The daily mean MODIS Aqua aerosol optical depth (AOD) and fine mode fraction (FMF) data from 2003 to 2020 are used to investigate how aerosol characteristics change over time and in different parts of India. Over the past 20 years, South India has displayed the lowest average AOD (0.36), while IGP has had the highest (0.62), as expected. FMF, a measure of anthropogenic aerosols, yielded an interesting result: the highest values were observed in the northeast region, especially in Gangtok (0.82), Itanagar (0.81), and Kohima (0.81). The lowest FMF was observed in Jaipur (0.52) in the west, where the coarse desert dust particles dominate, and also in Leh in the north (0.52) due to high elevation. The highest AOD was observed in the monsoon season in all regions except the northeast, where it was highest in winter. In Central India, the average yearly change in AOD and FMF went up at rates of 0.11 per decade and 0.07 per decade, respectively. Dust activity is highest in northern, IGP, and western India from March to May. This causes low FMFs because huge dust particles change the way aerosols are spread out. In the Northeast, FMFs are always higher than 0.7, with the highest values in winter (0.86) and after the monsoon (0.81).

Keywords: AOD, FMF, Trend

Biomass-Derived Carbon Sensors for Wearable Piezoresistive Applications

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Pyrolyzed carbon derived from biomass has emerged as a versatile material owing to its tunable electrical and piezoresistive properties. Among such resources, coconut fiber offers a sustainable and low-cost precursor for carbon production. In this work, we demonstrate the fabrication of a piezoresistive tactile sensor using carbon obtained from coconut fibers pyrolyzed at three different temperatures: 600 °C (CCP600), 800 °C (CCP800), and 1000 °C (CCP1000). The degree of graphitization was found to increase with temperature, leading to significant differences in sensing behavior. Notably, CCP600, despite its lower conductivity (ρ = 1.342 Ω·m, σ = 0.745 S/m), exhibited the best piezoresistive performance with a gauge factor (GF) of 37.81, which is decreasing for for CCP800 (15.12) and for CCP1000 (4.35). A similar trend was observed in load-dependent (0–3.02 g), resistance changes, with CCP600 showing the largest variation (up to 80 MΩ) and decreasing for CCP800 (0.24 MΩ) and CCP1000 (0.05 MΩ). Given its high gauge factor, CCP600 was further evaluated for touch, body motion and breath monitoring response. The response and relieve time study was conducted over with different cyclic loads (5,10,15, and 20N) with different frequencies (1,2 and 3Hz). These findings highlight that pyrolyzed coconut fiber at moderate temperatures provides an effective, low-cost pathway for fabricating reliable tactile sensors suitable for wearable and healthcare applications.

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Fe_3O_4/Carbon Nanocomposites Synthesis via Co-precipitation Method for Enhanced Adsorption of Crystal Violet

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Magnetic nanocomposites are emerging as efficient materials for wastewater treatment due to their tunable structures, high surface activity, and ease of recovery. Carbon was incorporated into the Fe_3O_4 matrix to enhance surface area and active sites for adsorption while simultaneously improving structural stability of the nanocomposite. The synthesized nanocomposite was characterized through XRD, FESEM, UV-Vis and Raman spectroscopy. The XRD pattern confirms the formation of crystalline magnetite (Fe_3O_4) with cubic phase and inverse spinal structure with ~14 nm crystallite size. The morphological analysis by FESEM confirms that the nanocomposite consists of uniformly distributed nanoparticles aggregated into a dense porous network. Raman spectroscopy confirmed the inverse spinel structure of magnetite and validates the successful incorporation of the carbon phase in the Fe_3O_4/C nanocomposite. Crystal violet was selected as the model pollutant because of its widespread use in textile and printing industries, high toxicity, and persistence in aquatic environments. The Fe_3O_4/C nanocomposite demonstrated remarkable dye adsorption efficiency, achieving 92.51% adsorption of crystal violet (10 ppm) within 1h**,** which is significantly higher compared to methylene blue, methyl red, and bromophenol blue. This enhanced performance arises from the synergistic interaction between carbon and Fe_3O_4, enabling efficient dye capture and facile magnetic separation. Our studies position Fe_3O_4/C nanocomposites as multifunctional adsorbents with high selectivity, recyclability, and potential for environmental and catalytic applications.

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Investigating the Central Nervous system activity of N-(3-methoxy-4-methylphenyl) benzenesulfonamide through DFT, Spectroscopy, and Bioactive evaluation

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Sulfonamides are frequently used in the synthesis of bioactive organic drugs. N-(3-methoxy-4-methylphenyl) benzenesulfonamide [MMBS], a sulfonamide derivative, has been examined for its anti-neurodegenerative properties using DFT and experimental methods like FT-IR, FT Raman, and NMR. In order to optimize the title compound and perform spectral calculations, DFT-B3LYP /6-311++ G (d, p) level of calculations [1] is used. The vibrational analysis demonstrates that the compound MMBS's bioactive properties are primarily caused by the N–H···O hydrogen bonding involving the ≻S(=O)$_2$NH≺ moiety. ADME/pharmacokinetic prediction was used to ascertain MMBS's oral active potential. Docking analysis with the target protein 3DU8 demonstrates MMBS's ability to participate in GSK-3 kinase. The title compound (Figure 1) exhibits both non-linearity and non-co-planarity, as evidenced by the dihedral angle of 60.9° between two benzene rings. The calculated torsional angles C18–C19–C20–C26 (179.4°) and C19–C20–C21–C27 (179.7°) data display that the methyl and methoxy substituents are coplanar with the N attached benzene ring. The HOMO-LUMO energy gap (3.43 eV) suggest that the compound is more reactive and this emphasise the possibility for their uses in pharmaceutical industry [2].

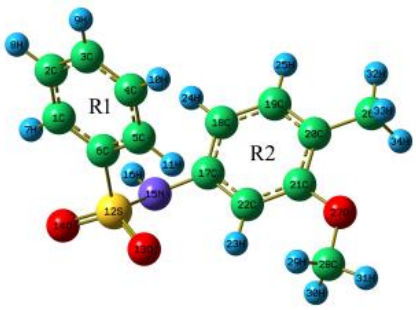

Figure. 1 Optimised structure of MMBS using B3LYP/6-311++ G (d, p)

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Nonlinear EEG Features as Diagnostic Signatures of Schizophrenia

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Schizophrenia is a chronic mental disorder that adversely affects cognitive abilities, memory, social behaviors, and overall quality of life. Electroencephalography (EEG) is an inexpensive tool that can assist neurologists in diagnosing abnormalities and identifying schizophrenia. Manual assessment of EEG signals in patients with schizophrenia is tedious, costly, and highly prone to human errors. Therefore, an autonomous, accurate, and cost-effective approach must be utilized to diagnose schizophrenia effectively.

The present study primarily focuses on automatically classifying the EEG signals of schizophrenia patients from healthy subjects. The procedure involves a succession of phases including EEG segmentation, preprocessing, feature extraction, feature selection, and classification. The block diagram of these phases are shown in Figure 1. This study employed multichannel EEG recordings and quantified various nonlinear methods such as the Hurst exponent, Higuchi fractal dimension, Elliptical area, and Interquartile distance from the 2D phase space. The k-nearest neighbor (KNN) and the support vector machine (SVM) algorithms with various kernels were tested for schizophrenia detection. Results demonstrate that the proposed approach exhibits excellent performance with an accuracy of 98.63% using the KNN algorithm, outperforming existing works.

By providing a fast, reliable, and non-invasive diagnostic framework, this study can support neurologists in early and precise identification of schizophrenia. Ultimately, patients will benefit from timely intervention, improved treatment planning, reduced misdiagnosis, and an enhanced quality of life.

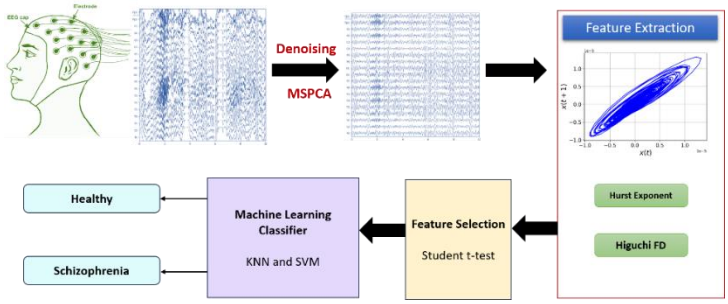

Figure 1. Block diagram of the proposed method for schizophrenia detection from EEG signals.

Study on Dynamics of Photosensitive *Caenorhabditis Elegans*

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Phototaxis is a typical behaviour in animals with light-sensing organs. C. elegans is often thought to be devoid of phototaxis because it lives in darkness and is blind. Light stimulation triggered negative phototaxis in C. elegans, which is critical for survival.

To study photosensitive effect in C-elegens gene regulatory networks and connectome models are used to anticipate how light interacts with its biological systems. It helps to identify essential genes and proteins implicated in the photosensitivity effect. The Keller-Segel model is used to investigate C. elegans aggregation, in which a population of worms (or individual cells) forms dense clusters in response to chemical signals. In the current study, the Keller-Segel equations give a mathematical framework for linking C. elegans biological behaviours (such as chemotaxis and aggregation) to the underlying chemical and genetic components, allowing for a better understanding of these complex systems. The functional conservation of neural processes, together with the great similarity between nematode and human genomes, make C. elegans very appropriate for the study of human neurodegenerative illnesses.

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Development of Micro Heater Through Laser Graphitization

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The majority of microheaters on the market are produced through labor-intensive processes and are exceedingly expensive. This study focuses on developing a cost-effective, simple, and all-carbon high-temperature microheater using laser graphitization. In the two-step continuous laser graphitization process, the surrounding polymer is first removed using the invert function, followed by graphitization of the carbon coil pattern in the next stage. Both steps are performed using the same laser power, ensuring that the carbon coils remain on top of the substrate while preventing unwanted carbonization of the surrounding polymer, which could otherwise cause degassing and limit applicability in high-vacuum environment. A carbon microheater, capable of reaching temperatures up to 450 °C in an open atmosphere and 660 ^{0}C in inert atmosphere, is fabricated by laser graphitizing polyimide tape on a glass slide. This easy and cost-effective method provides a viable solution for fabricating microheaters suitable for vacuum heating, capable of achieving high temperatures.

Engineering the Phase Diagram in CP + W + sBA towards a Possible Quadruple Critical Point using Potassium Thiocyanate

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Detailed studies on the phase diagram of the system cyclopentanone (CP) + water (W) + secondary butyl alcohol (sBA) by our group [1] showed the existence of a tunnel like feature for the CP weight fraction range $0.100 \leq X_{cp} \leq 0.400$ with the minimum *critical diameter* of $D_{min} = 124.926\ K$ occurring at $X_{CP} = 0.250$ and at a temperature range $329.272K \leq \Delta T \leq 354.198K$. On account of both D_{min} and ΔT, CP + W + sBA is a more promising system for exploration of the Quadruple Critical Point (QCP) compared to the system methyl ethyl ketone (MEK) + W + sBA [2, 3].

We report detailed studies aimed at engineering the phase diagram in CP + W+ sBA such that a Quadruple Critical Point may be realized in this system. For very small amounts of potassium thiocyanate (KSCN) in the weight fraction range of $0.001000 \leq X_{KSCN} \leq 0.001800$ it is observed that the *critical-tunnel* in the phase diagram of CP + W + KSCN gets completely pinched off and splits into two parabolic critical lines each with a Double Crtiical Point (DCP) at its vertex. The amount of ionic impurity required in the system CP + W + sBA is an order of magnitude smaller than that required in case of the system MEK + W + sBA [2]. The closest approach to the QCP is seen for $X_{KSCN} = 0.001200$. However, the line of critical points obtained are suggestive of chemical complexities in the system CP + W + sBA + KSCN. The QCP coordinates are predicted to be at $(X_{cp}, X_W, X_{sBA}, X_{KSCN}, T) = (0.2518, 0.5711, 0.1759, 0.0012, 344.841K)$, where X_W and X_{sBA} represent the weight fraction of water and sBA in the mixture.

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Performance Analysis of Zinc Oxide Thin film Transistors with varying device parameters for sensing applications

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This paper presents a detailed simulation-based analysis of zinc oxide (ZnO) thin-film transistors (TFTs), focusing on the impact of key structural parameters—such as channel width, length, and thickness—on their electrical characteristics. Parameters including threshold voltage, field-effect mobility, on/off current ratio, subthreshold slope, and drain current are evaluated. The effect of using noble metals like palladium and platinum as source/drain electrodes is also examined, with particular attention to their work function and its influence on carrier injection and drain current. The analysis is carried out using the ATLAS module of Silvaco TCAD by extracting transfer characteristics under various conditions. Device performance is systematically studied by varying gate oxide thickness, channel dimensions, and electrode materials, providing insights into the design optimization of ZnO TFTs for high-performance electronic and sensing applications.

Keywords: ZnO TFTs, on-off current ratio, threshold voltage, drain current, subthreshold slope

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Fabrication of graphitic carbon nitride thin film for photocatalytic degradation of Rhodamine B

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Photocatalysis addresses multiple challenges, including the purification of wastewater, the breakdown of volatile organic substances, and the removal of dyes, among others. Overcoming the limitations of photocatalytic powder, such as the low efficiency of separation and recovery after the photocatalytic dye degradation process. The synthetic dye Rhodamine B (RhB) poses serious ecological and health risks due to its persistence in aquatic environments, largely attributed to its resistance to natural degradation. The purpose of this research is to highlight the current breakthroughs in using g-C_3N_4 for dye degradation. The photocatalytic degradation of Rhodamine B using g-C_3N_4 thin film was evaluated under visible light irradiation. The effect of dye concentration on the photocatalytic activity of g-C_3N_4 thin films was studied and it is observed that these thin films are effective photocatalysts for the degradation of Rhodamine B (RhB) under visible light due to enhancement in charge separation, light absorption, and stability.

Keywords: Graphitic carbon nitride thin film, Photocatalytic dye degradation, Rhodamine B, Wastewater.

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Electron impact ionization cross sections of Be and its ions

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The electron impact ionization process is a fundamental phenomenon in atomic physics, significantly influencing fields such as plasma physics, semiconductor physics, astrophysics, and fusion research. Beryllium, a light element, is particularly important due to its applications in fusion reactors [1]and its implications for materials science. Understanding the electron impact ionization cross sections of beryllium is crucial for modeling plasma environments in which it is present. These cross sections are vital for predicting and controlling plasma behavior in fusion reactors, ensuring the stability and efficiency of the reactions.

We report the electron-impact ionization cross sections for neutral beryllium (Be) and its ions (Be^{+}, Be^{2+}, and Be^{3+}) within the frameworks of the Binary Encounter Dipole (BED), Coulomb Born Exchange (CBE), and Distorted Wave (DW) methods [2]. The ionization cross sections have been calculated for energies ranging from the ionization threshold up to 100 eV, considering both the ground state and the first excited state of beryllium. A detailed comparison will be made between the calculated cross sections and existing theoretical and experimental data.

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Surfactant Assisted synthesis of $MgFe_2O_4$ Nanostructures via Hydrothermal and Solvothermal methods for Supercapacitor applications

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Magnesium ferrite ($MgFe_2O_4$), a spinel-type transition metal oxide, is considered as a promising electrode material for supercapacitors due to its redox-active sites, structural stability, and eco-friendly nature [1]. In this work, $MgFe_2O_4$ was synthesized via hydrothermal and solvothermal methods under different growth conditions utilizing various surfactants like glycerol, oxalic acid, and ascorbic acid as structure-directing agents. Its crystallographic, morphological and chemical configurations were investigated using XRD, Raman, FESEM and XPS. Electrochemical performance of prepared nanostructures was systematically investigated in 3 M KOH electrolyte within the potential window of 0–0.5 V by GCD analysis. The glycerol-assisted sample, which developed a spherical morphology (Solvothermal), exhibited the highest specific capacitance of 636 F g^{-1} at current density of 1 A g^{-1}, while the oxalic acid-assisted sample with a rod-like morphology (Solvothermal) and the ascorbic acid-assisted sample with a flower-like morphology (Hydrothermal) exhibited 532 F g^{-1} and 478 F g^{-1} at 1 A g^{-1}, respectively. The specific capacitance value of $MgFe_2O_4$ nanospheres in this study is approximately 212% higher than pure $MgFe_2O_4$ and 152% higher than the Zn doped $MgFe_2O_4$ in the literature [2], which is a significant effect of surfactants.

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Electrochemical Investigation of High Entropy Spinel Oxide for Supercapacitor Application

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The growing global demand for energy poses a significant challenge to achieving sustainable development. The advancement of energy storage technologies strongly relies on the development of novel materials, among which high-entropy materials have emerged as promising candidates due to their extraordinary electrochemical properties. In this study, high-entropy oxide (HEO), $(Mg_{0.21}Cr_{0.21}Mn_{0.21}Fe_{0.21}Cu_{0.16})_3O_4$, was synthesized via a sol–gel method followed by high-temperature calcination. Structural characterization confirmed that achieving optimal stoichiometry is crucial for the formation of a single-phase spinel-structured HEO. XRD and electrochemical studies highlighted the role of multi-element interactions in stabilizing the spinel phase and enhancing the electrochemical behaviour. The redox activity of the HEO in KOH electrolyte occurred within the desirable potential window of 0–0.4 V, demonstrating a pseudocapacitive charge-storage mechanism. The material exhibited a high specific capacitance of 241 F g^{-1} at 1 A g^{-1} and maintained 86% of its capacitance after 2000 cycles, underscoring its good electrochemical stability and cycling durability. These findings emphasize the potential of spinel-structured high-entropy oxides as advanced electrode materials for next-generation supercapacitors, offering improved energy storage performance and long-term stability.

Hydrothermally derived alpha-MoO_3 Nanoparticles as promising Electrode for Supercapacitor applications

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Supercapacitors, also known as electrochemical capacitors or ultracapacitors, are advanced energy storage devices that bridge the gap between conventional capacitors and batteries. A wide range of electrode materials has been explored for supercapacitor applications, including carbon-based materials, metal oxides, and conducting polymers. Among these, metal oxides have acquired considerable attention because of their high pseudocapacitance. In particular, molybdenum trioxide (MoO_3) is of special interest due to its layered structure, variable oxidation states, and high theoretical capacitance (1340 F/g). Based on these advantages, our research emphasizes MoO_3 as a promising electrode material for improving supercapacitor performance. Molybdenum trioxide (MoO_3) was prepared through a simple hydrothermal method. XRD analysis confirmed the formation of α-MoO_3 nanostructures. Field Emission Scanning Electron Microscopy (FESEM) showed a layered, flake-like morphology of the sample. Energy dispersive spectroscopy (EDS) analysis verified the elemental composition, while Raman spectroscopy further confirmed the presence of characteristic vibrational peaks of α-MoO_3 nanoparticles. Electrochemical performance was studied using a standard three-electrode cell system. Cyclic voltammetry (CV) curves exhibited clear redox peaks, indicating the pseudocapacitive nature of the material. The specific capacity, determined from galvanostatic charge–discharge (GCD) curves, was 70 C/g at specific current of 1 A/g. Hence, this material can be considered a suitable candidate for supercapacitor applications.

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Development of Mn-MIL 100 MOF derived manganese oxide for asymmetric supercapacitors application

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The ability to control their structure and phase by simply adjusting the calcination temperature provides a powerful method for tailoring their properties for a wide range of energy storage applications. In this study, we aimed to develop manganese oxides from MOF Mn-MIL 100 by heat-treated at various temperatures (400, 600, 800, 1000, and 1200 °C) in an air environment. This process was a strategic way to induce distinct phase changes of Mn and enhance the materials' performance for supercapacitor applications. The Mn-800 electrode, which was calcined at 800 °C, exhibited the best performance among the materials developed for this study. It achieved a high specific capacitance of 289.5 F g^{-1} at a current density of 1 A g^{-1}, outperforming both the original Mn-MIL-100 material and those treated at other temperatures. The material also showed impressive durability, maintaining 78% of its initial capacitance after 2000 charge-discharge cycles. Further, to ensure practical viability of the asymmetric supercapacitor (ASC) with a counter-electrode (Mn-800||SPC), the device delivered a specific capacitance of 40 F g^{-1} at 1 A g^{-1}, which demonstrated a significant energy density of 11.9 Wh kg^{-1} and a power density of 730 W kg^{-1}. This device also proved that the studied ASC retained 82% of its capacitance after 3000 cycles. The ability to control their structure and phase by simply adjusting the calcination temperature provides a powerful method for tailoring their properties for a wide range of energy storage applications.

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Development of Nitrogen rich carbons on Metal oxide clusters for Symmetric Supercapacitors

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The covalently functionalized GO with APTES on Mn-MIL 100 metal oxide framework (MOF) to develop N-rich carbons on Mn based MOF by annealing at 400˚ C in the N_2 atmosphere. The PXRD pattern confirms that the presence of an amorphous form of Mn-oxides and the presence of nitrogen was confirmed by EDX and CHNS analysis. As expected, that N-rich carbons with the metal-carbon clusters enhanced the supercapacitor performances. The developed Mn/NC-400 electrode employed as the positive electrode for supercapacitors delivered a well pronounced conductivity, a high specific capacitance of 584 F/g at 1 A/g. The results indicate that the C-N-M clusters promoted rapid electrolyte diffusion, fast kinetics in terms of electron transport and high charge & discharge rates. Thus, the developed electrode may have the potential for the development of novel energy storage systems suitable for portable, miniatured and wearable power devices.

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Arc Plasma-assisted Rapid and Green Synthesis of Biomass Derived Graphitic Carbon for Supercapacitor Applications

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Graphitic carbon is a promising material for energy storage applications like supercapacitors, owing to its exceptional electrical and thermal conductivities, chemical stability, and high surface area. Producing this material from biomass is a sustainable and cost-effective alternative to fossil fuel-derived precursors. However, conventional synthesis methods require prolonged high-temperature treatments ($\sim 10^3$ K), which are energy-intensive and time-consuming. This work explores a novel, rapid, and green method using arc plasma to convert *Lantana Camara (LC)*, a lignocellulosic biomass, into high-quality graphitic carbon. During the plasma treatment, both pyrolysis and graphitization occur simultaneously as the biomass is exposed to high-temperature plasma generated from N_2, $Ar+H_2$, and CO_2 gases. Structural analysis, including X-ray diffraction and Raman spectroscopy, confirms the successful formation of graphitic carbon with a high degree of graphitization (98.8%) and minimal defects. Electrochemical characterization in a three-electrode system demonstrates that the synthesized carbon exhibits excellent reversibility in charge-discharge cycles, good cyclic stability, and a notable specific capacitance. This arc plasma-assisted method offers a promising solution to key challenges in conventional biomass carbonization, such as the need for long processing times and the use of activating agents, positioning it as a viable pathway for the rapid and environmentally friendly production of high-performance carbon for supercapacitor applications.

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Nakshathra Vanam: Advancing Indigenous Knowledge and Community Empowerment

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Indigenous knowledge systems (IKS) have long been integral to the sustainability and cultural cohesion of indigenous communities worldwide. These systems, which are rooted in the traditions, beliefs, practices, and experiences of indigenous peoples, offer valuable insights for contemporary community development. This research paper explores the role of IKS in community development, highlighting the relevance of these systems in fostering sustainable practices, preserving cultural heritage, and promoting self-determination through service-learning approach. It also critically examines the challenges of integrating indigenous knowledge into modern development practices, arguing for a more inclusive, interdisciplinary approach to community development that respects and utilizes indigenous ways of knowing. The present work envisages the concept of Nakshathra Vanam by thoughtfully integrating the energy of the Nakshatras into the design, it offers a spiritually rich environment that nourishes not only the body but also the mind and soul for the stakeholders of the UCC campus since 2023. Whether it is used for personal growth, spiritual rituals, or simply as a place of peace and reflection, UCC Nakshatra Vanam provides a unique way to reconnect with the rhythms of the universe since the time of its inception.

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On the Stability of Topological Invariants in Fractal Constructions Using Persistent Homology

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Fractal structures [4], known for their intricate self-similarity and non-integer dimensionality [3], are sensitive to perturbations in both theoretical construction and real-world approximations. In this study, we investigate the stability of topological invariants, particularly those arising from persistent homology [1,2], in the context of self-similar fractals and their perturbations. We focus on the behavior of the 0-dimensional persistent homology (PH_0) and its associated persistent homology dimension (PH-dim) when fractals are discretized, sampled with noise, or subjected to small structural deformations. Using a combination of Vietoris-Rips filtrations and weighted simplicial complexes, we analyze how topological features such as connected components persist under variations in the underlying fractal geometry. We also provide theoretical bounds and empirical evidence demonstrating the robustness of PH-dim compared to traditional metrics such as Hausdorff and box-counting dimensions. The results highlight the potential of persistent homology as a stable and noise-resistant tool for characterizing fractal complexity in both idealized and practical settings.

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Impact of Digital Convergence on Television News and Its Role in Shaping Public Opinion and Political Discourse

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Digital convergence has greatly expanded the influence of television news by integrating traditional broadcasting with internet-based technologies. In Kerala, Malayalam news channels enjoy a vast reach and popularity comparable to leading global counterparts. Advances in satellite transmission, high-definition imaging, and streaming integration have removed the constraints of scheduled telecasts, creating a hybrid media ecosystem where news flows seamlessly across platforms and devices. Through mobile apps, OTT services, and social media links, content recirculates continuously, fostering both repeated exposure and active participation. This technological architecture transforms news into a sustained, networked experience that extends its influence well beyond the moment of broadcast. The persuasive power of television news is further amplified by algorithmic recommendations, interactive features, multi-screen access, immersive graphics, real-time updates, and cross-platform dissemination, which together reinforce frames and narratives, heighten emotional resonance, keep politically charged messages visible and shareable, anddrive audience engagement where opinion formation is shaped as much by technological delivery as by content. The study explores how digital convergence influences television news and public opinion by content analysis of broadcasts and digital platforms with qualitative interviews of producers and focus groups representing diverse consumers. The findings reveals that digital convergence has redefined mechanisms of influence in political discourse, amplified the reach of television news through strategic repurposing beyond broadcast audiences, and underscores that understanding this transformation is essential to explain television's continued role in shaping democratic participation in a hybrid, digitally mediated era.

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A Cost-Effective Business Model for Edge AI Implementation for improved RoI in SMEs

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In the recent years, Edge computing and edge analytics are gaining popularity and is shown a lot of interest by IoT system developers, researchers and businesses. Edge analytics is bringing about a paradigm shift in the enterprise IoT ecosystem in a steady pace.

In an edge computing framework, instead of allowing all the raw data generated from the edge devices flow to the cloud server, they are processed locally at the edge gateways and only selected data or the insights alone flow to the cloud server. Edge computing can hence be understood as the technique of data acquisition, processing and analysis of the collected data close the source of the data, at a device like an IoT gateway or a network switch or some other custom built device with sufficient computing power. This enables real time and in-situ analysis of the huge data collected from various sensors and IoT devices.

This is crucial for industries, especially SMEs, because they enable faster data processing by bringing computation closer to the source—reducing latency, improving real-time decision-making, and cutting cloud costs. This is especially valuable for SMEs with limited bandwidth or budget, allowing them to deploy intelligent automation, predictive maintenance, and customer insights without relying on heavy infrastructure.

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Enhancing organizational efficacy of small farmers' groups: A comparative analysis of Indian and Japanese Agricultural Cooperatives

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The transformation of agriculture marked the start of the economic development of almost every developed nation (Rao et al., 2022). The government and private sectors are promoting innovative practices to boost agriculture by seeking transformation plans for cost-effective, innovative methods to lessen their financial burden on agriculture (Glover, 2022; Liu et al., 2022). But sometimes, these creative practices may not be farmer-friendly. It may cause severe damage to long-term agricultural production, may not be sustainable, and may not consider the opinion or comments shared by the small-scale farmers. It may be entirely against the indigenous practices followed by the farmers or may face regional socio-political challenges to execute the plan (Ferrari et al., 2022). As a result, the governments are now ensuring the participation of small-scale farmers and indigenous farmers groups in developing transformation plans (Narh, 2022; Tsakiridis et al., 2022).

The socio-cultural and political factors that underpin the actual agricultural development of a nation or a region can only be addressed by building the self-governing organizational capacity of the framers' organizations to withstand the shocks or uncertainties related to the contextual factors. By incorporating the design principles theory proposed by Nobel laureate Ostrom (2009) this study compares the efficacy of Indian farmer self-help groups (SHG) and Japanese Agricultural Cooperative (JA). The primary objective is to compare the organizational capacity of Indian agricultural SHGs and JA. The self-governance organizational capacity intends to achieve sustainable agriculture production with effective management of farmers organizations in a country.

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Indoor Air Quality Monitoring and Health Risk Assessment in an Institute Gym

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Gyms are unique indoor environments where high physical activity levels exacerbate the generation and dispersion of fine particles, potentially affecting air quality and human health. Indoor air quality (IAQ) in air-conditioned gyms plays a critical role in the health and performance of occupants - gym-goers, who typically engage in high-intensity activities for 1–2 hours per session daily, face elevated exposure to airborne pollutants due to increased respiratory rates, potentially leading to respiratory issues and other health risks. This study investigates IAQ in an institute gym, focusing on particulate matter (PM_{10}, $PM_{2.5}$, PM_1), carbon dioxide (CO_2), nitogen dioxide (NO_2) and Total Volatile Organic Compounds (TVOCs) alongside other comfort parameters such as temperature and humidity.

PM, CO_2, NO_2 and TVOCs were measured using real time monitoring equipment (Grimm MiniLAS, Delta Ohm IAQ Meter and GrayWolf IAQ meter), and data collection was done across three consecutive weekdays (Tuesday, Wednesday, Thursday) encompassing peak occupancy hours (morning and evening) and non-working hours. The measured parameters' data was logged at one-minute intervals, and the results were analysed using descriptive and inferential statistical methods, including Pearson's correlation to examine relationships between pollutants and IAQ parameters.

The observed PM concentrations were within the WHO limits (PM_{10} : 45 µg/m³, $PM_{2.5}$: 15 µg/m³) and CO_2 concentrations were observed to be exceeding the ASHRAE limits of 1000 ppm. Also, there are no defined limits for TVOCs. Inhalation risk of PM has been estimated employing the deposition fraction during each activity in the gym.

Keyword: Particulate matter, Carbon dioxide, Nitogen dioxide, Total Volatile Organic Compounds, Indoor air, Inhalation Health risk

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