REPORT ON

Two Days International Seminar

on

Emerging Trends in Science: Challenges and Opportunities

Organised by

Department of Chemistry in collaboration with IQAC, St. Joseph's College, Darjeeling

Date: 7th – 8th April2025

VENUE: St. Joseph's College, Darjeeling.

1. Brochure

St. Joseph's College
Darjeeling

Two Days International Seminar on

Emerging Trends in Science: Challenges and Opportunities

7th and 8th of April 2025

Organised by the Department of Chemistry in collaboration with the IQAC St. Joseph's College, Darjeeling

About the Seminar:
The Seminar aims to discuss the recent emerging trends in science and highlights the increasing importance of interdisciplinary research. Interdisciplinary collaboration fosters innovation by bringing together diverse perspectives, methodologies and technologies leading to more comprehensive and effective solutions. The recent trends in science plays a crucial role in tackling global challenges in the field of energy, human health, medicines, biomedical technologies, sustainable materials etc. By recognising and addressing the challenges while embracing the opportunities presented by these emerging trends, science can continue to drive progress and improve the world.

Invited Speakers

Dr. Anand Pariyar
Sikkim University

Dr. Avinash Chettri,
University of Potsdam, Golm, Germany

Dr. Moumita Rana,
Delft University of Technology/ TU Delft, Netherlands

Dr. Ranjit Kumar Singh
Physikalisch-Technische Bundesanstalt Braunschweig, Germany

Dr. Madhukar Hemamalini,
Mother Teresa Women's University,
Kodaikanal, Tamil Nadu

Dr. Kuldeep Mahato,
Department of Nanoengineering
University of California, San Diego

Dr. Rishabh Shukla,
University of Hawaii, USA

Dr. Sanjeeta Tamang
School of Medical Sciences
University of Birmingham

Patron
Fr. Dr. Donatus Kujur, S.J.
Principal, St. Joseph's College, Darjeeling
Convenor
Dr. Rajani Dewan
Joint Convenor
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IQAC Coordinator
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Dr. Sailesh Chettri
Organising Committee
Dr. Antara Sharma
Dr. Rajendra Pradhan
Dr. Upakar Rai
Mrs. Albina Subba
Ms. Sweta Mukhia
Dr. Pravat Dangal

Paper Presenters

1. Fr. Dr. James Antony, Assistant Professor, Department of Microbiology St. Joseph's College, Darjeeling
2. Dr. Ratul Datta Chaudhuri, Assistant Professor, Department of Zoology, St. Joseph's College, Darjeeling
3. Dr. Suman Chhetri, Assistant Professor, Department of Chemistry, St. Joseph's College, Darjeeling
4. Dr. Sailesh Chettri, Assistant Professor, Department of Chemistry, St. Joseph's College, Darjeeling
5. Mr. Sumiran Tamang, Assistant Professor, Department of Chemistry, St. Joseph's College, Darjeeling
6. Dr. Dibya Gulab Minj, Assistant Professor, Department of Mathematics, Holy Cross Women's College, Ambikapur
7. Dr. Priyam Chakraborty, Assistant Professor, Department of Mathematics, St. Joseph's College, Darjeeling
8. Dr. Nishal Rai, Assistant Professor, Department of Physics, St. Joseph's College, Darjeeling.
9. Dr. Rajani Dewan, Assistant Professor, Department of Chemistry, St. Joseph's College, Darjeeling.
10. Dr. Antara Sharma, Assistant Professor, Department of Chemistry, St. Joseph's College, Darjeeling.
11. Dr. Dhiraj Brahman, Assistant Professor, Department of Chemistry, St. Joseph's College, Darjeeling.
12. Dr. Abhijit Chhetri, Assistant Professor, Department of Microbiology, St. Joseph's College, Darjeeling.
13. Albina Subba, Assistant Professor, Department of Zoology, St. Joseph's College, Darjeeling.
14. Barkha Rai, Assistant Professor, Department of Zoology, St. Joseph's College, Darjeeling.
15. Dibyashree Chhteri, Assistant Professor, Department of Microbiology, St. Joseph's College, Darjeeling.
16. Sweta Mukhia, Assistant Professor, Department of Microbiology, St. Joseph's College, Darjeeling.
17. Shuvam Sharma, Assistant Professor, Department of Zoology, St. Joseph's College, Darjeeling.

2. SEMINAR/WORKSHOP DETAILS:

- **Title:** Emerging Trends in Science: Challenges and Opportunities
- **Date:** 7th-8th April 2025
- **Time:** 9:00am
- **Venue:** MR Hall, St. Joseph's College, Darjeeling
- **Funding Agency**: College Fund

3. Keynote Address:

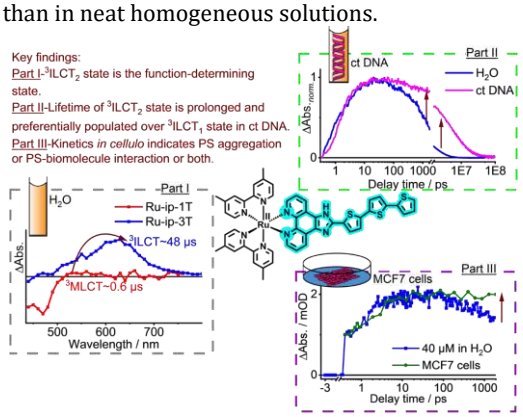
- **Topic:** Emerging Trends in Science: Challenges and Opportunities
- **Name:** Dr. Anand Pariyar
  Assistant Professor
  Department of Chemistry,
  Sikkim University, Gangtok, Sikkim

ABSTRACTS

Investigating the light-induced dynamics of a phototoxic Ru (II)-based photosensitizer, TLD1433, in biologically relevant environments.
Dr. Avinash Chettri - University of Potsdam

The talk focuses on the photophysical properties of a Ruthenium-based photosensitizer (PS), TLD1433, currently under human clinical trial for the treatment of non-muscle invasive bladder cancer with Photodynamic Therapy (PDT), a noninvasive cancer treatment modality which uses light of suitable wavelength to excite PS to long-lived triplet states, which in turn generates reactive oxygen species (ROS) causing selectively annihilation of cancer cells. The excited-state landscape which governs the reactivity and therefore the functionality of the PS is thoroughly investigated with optical time-resolved spectroscopic techniques such as femtosecond and nanosecond transient absorption and emission spectroscopy in conjunction with steady-state spectroscopic techniques such as absorption, emission and resonance Raman spectroscopy, in different biologically relevant environments. The overall findings disseminated in this talk will show that the biological environment alters the photophysical properties of the PS and in general, emphasizes on the

need to correlate the functionality of PSs used in relation to PDT to their photophysics in systems which can replicate the *in cellulo* environment rather than in neat homogeneous solutions.



The scheme shows the chemical structure of TLD1433, and the key findings obtained with respect to TLD1433's photophysical properties, in different biologically relevant environments, with optical time-resolved spectroscopic techniques.

Dietary essential oil components: Preclinical studies on the management of gastrointestinal diseases.
Fr Dr Poovathumkal James Antony – St. Joseph's College, Darjeeling

Human gut plays a crucial role in digestion, nutrient absorption, immune regulation, and maintaining the intestinal barrier. However, factors such as poor diet, stress, and infections cause dysbiosis, leading to inflammation and dysfunction. Studies indicate that dietary plant-derived essential oil components, including carvacrol, cinnamaldehyde, citral, D-limonene, eugenol, farnesol, geraniol, indole, thymol, vanillin, α-linolenic acid, α-pinene, α-terpineol, β-carotene and many more are beneficial on gut health and intestinal function in animal models.
The essential oil components modulate the expression of pro-inflammatory and anti-inflammatory markers, including tumor necrosis factor-α, interleukin-1β, interleukin-6, interleukin-10, inducible nitric oxide synthase, cyclooxygenase-2, toll-like receptor-4, matrix metalloproteinases, and interferon-γ helping to reduce gut inflammation.
The major signaling pathways influenced by these phytochemicals, include AMP-activated protein kinase, protein kinase B, c-Jun N-terminal kinase, mitogen-activated protein kinase, myeloid differentiation primary response-88, nuclear factor erythroid-2, and phosphoinositide 3-kinase. Additionally, these compounds improve glucose metabolism by regulating glucose transporter-4, glucagon-like peptide-1, peroxisome proliferator-activated receptor gamma, nuclear factor kappa B and many more.
Therefore, plant-derived essential oil components could be used as potential therapeutic agents to alleviate inflammation, oxidative stress and enhance gut function. They are recommended as prebiotics to enhance GMB growth, which is crucial for maintaining immune system balance and preventing chronic diseases, like inflammatory bowel disease, colorectal cancer, T2DM, polycystic ovary syndrome, and cardiovascular disease. However, further clinical studies are necessary to fully understand their potential benefits for the management of gastrointestinal diseases in human.

Cardiac hypertrophy— the yin and the yang.
Dr. Ratul Datta Chaudhuri - St. Joseph's College, Darjeeling

The mammalian heart has a remarkable ability to remodel itself in response to an increased workload. It tries to adapt itself to meet its blood-pumping efficiency by enlarging in size— a condition known as cardiac hypertrophy. However, not all instances of hypertrophy result in betterment of cardiac function. Depending upon the nature and intensity of the stimulus, the cardiac function is either enhanced or deteriorated— the phenomena being known as physiological or pathological cardiac hypertrophy, respectively. For example, long-term exercise training leads to physiological hypertrophy, whereas hypertension causes pathological hypertrophy. In both the cases, there is active synthesis of cellular proteins to meet the hypertrophic needs of the cardiomyocytes, but what really sets them apart is the difference in the cellular signaling pathways that are triggered by the ensuing stimulus. Using various biotechnological tools we can have a detailed insight into such signaling pathways to understand the molecular basis of a good heart and a bad one. The aim of emerging molecular medicine in the field of cardiology has been to dissect out key cellular molecules like intracellular proteins that can potentially be targeted by various therapeutic approaches to ensure the proper functioning of the heart.

Pharmaceutical cocrystals, Hydrogen bonding, and Chemistry career opportunities for students.
Dr. M. Hemamalini – Mother Teresa Women's University, Kodaikanal

Pharmaceutical cocrystals, multicomponent crystalline forms of active pharmaceutical ingredients (APIs), offer a powerful strategy to modulate physicochemical properties like solubility and bioavailability. Hydrogen bonding plays a pivotal role in cocrystal formation and stability, driving the self-assembly of API and coformer molecules. This

abstract highlights the significance of understanding and exploiting hydrogen bonding interactions for rational cocrystal design. By strategically selecting coformers with complementary hydrogen bonding functionalities, researchers can engineer cocrystals with tailored properties, addressing challenges in drug development. This approach necessitates a deep understanding of intermolecular interactions and solid-state chemistry. Techniques such as single-crystal X-ray diffraction, spectroscopy, and computational modeling are crucial for characterizing hydrogen bonding networks and predicting cocrystal behavior. The exploration of hydrogen bonding in pharmaceutical cocrystals opens avenues for developing novel drug formulations with enhanced efficacy and stability, ultimately improving patient outcomes.

Key words: Crystal Structure, pharmaceutical co-crystals, hydrogen bonding

How Do Charge Carrier Transport and Microstructure Influence Solid State Battery Performance: Solving the Jigsaw.

Dr. Moumita Rana - Delft University of Technology, The Netherlands.

Solid state lithium ion batteries are promising as the next-generation energy storage system due to their high energy density, thermal stability, and volumetric miniaturization. Even though, the ionic conductivity of solid state electrolytes is often blamed to be the bottle neck of the limited performance of the solid state batteries, in reality, it is dependent on the effective charge carrier transport in the electrode composite. In particular, the effective ionic and electronic conductivity of the solid state electrodes strongly relies on the microstructure of the electrode composites. In this talk, I am going discuss two instances on how altering the microstructure of the electrode composite affects the solid state battery performance: (i) the active material: for example silicon particle size. The particle size of silicon is found to significantly influence the effective transport properties, which in turn modulate the rate performance as well as the long-term stability. This study provides a comprehensive understanding on the role of charge carrier transport in achieving high-performance silicon based anode for solid-state batteries. (ii) The solid electrolyte (SE), namely Argyrodite: by varying the particle size of the solid electrolyte, the porosity of the composite electrode and the relative distribution of the electroactive material in the composite were altered. This significantly influenced the overall effective ionic and electronic conductivity of the electrode composite, which effect the solid-state battery performance.

References:

[1] A solid future for battery development. Nat. Energy 2016, 1, 16141.

[2] Toward Achieving High Areal Capacity in Silicon-Based Solid-State Battery Anodes: What Influences the Rate-Performance? ACS Energy letters 2023, 8 , 3196

[3] Investigating the Influence of the Effective Ionic Transport on the Electrochemical Performance of Si/C-Argyrodite Solid-State Composites, Batteries & Supercaps 2023, e202300211.

[4] Impact of the Solid Electrolyte Particle Size Distribution in Sulfide-Based SolidState Battery Composites, Advanced Energy Materials 2023, 13, 2302309.

Toward the realization of an innovative desalination technology through solar thermal conversion

Dr. Suman Chhetri – St. Joseph's College, Darjeeling

The growing concern about depleting fresh water sources, limited access to clean water in proportion to the growing population and unaffordable purification systems, particularly for developing nations, are some of the key factors encouraging the advancement of sustainable technologies for water purification. The existing reverse osmosis-based desalination technologies are unable to cater to the needs of remote and distressed areas due to the very high energy requirement and design cost. The solar-powered seawater desalination has the potential to circumvent the freshwater shortage and could replace the energy-intensive existing desalination process. However, the conventional approach of solar-driven desalination process, which involves bulk water heating, is not in line with the demand of fresh water due to its low photothermal conversion efficiency. Recent years have witnessed the upsurge of innovative photothermal materials designed for solar-driven interfacial water evaporation process, wherein the localized heat generated by the solar absorber at the evaporative interfaces would drive the evaporation process. The rational design of both the solar absorbing material and evaporation system have resulted in higher evaporation efficiency. However, for solar-driven interfacial water evaporation process, salt accumulation is the hurdle to its continuous operation, which impedes the long-term sea water desalination. Therefore, the challenge is to design salt-rejecting and self-regenerating photothermal structure with high evaporation rate for practical implementation of solar driven interfacial water evaporation-based desalination process on an industrial scale. This talk aims to present the idea of the fabrication of an inexpensive high efficiency interfacial solar-thermal desalination prototype capable of producing pure drinking water. To meet this aim, the independent development of both a high efficiency evaporator and condensing surface were approached utilizing benign fabrication methods.

Green Chemistry: The Future of Organic Synthesis

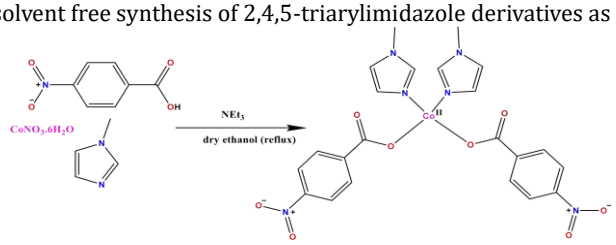
Dr. Sailesh Chettri – St. Joseph's College, Darjeeling

According to the principles of Green Chemistry, solventfree multicomponent reactions are one of the crucial tools for quickly completing organic synthesis and functional group transformations, which makes it possible to synthesize a large range of organic compounds in a very efficent and clean manner.

In addition to being a noble approach, green chemistry is also practical and an economical way for organic synthesis in the future.
It keeps chemical production innovative and efficient while adhering to global sustainability goals. There are many Nitrogen containing heterocyclic compounds which can be synthesized using a variety of techniques, but majority of them have a number of disadvantages including low yield, harsh reaction conditions, the use of hazardous solvents, longer reaction times and laborious work up procedures. Taking all these factors into consideration, the transition metal borates can serve to be good candidates as catalysts for the multi component synthesis of a nitrogen containing heterocyclic compounds. Therefore, the synthesis of some of the important nitrogen containing compounds like 2,4,5-triaryl imidazole and 1-hydroxy-2-arylimidazole-3-oxide were done using Copper Borate as a catalyst.
Keywords: Green chemistry, solvent free, multicomponent reactions, 2,4,5-triaryl imidazoles

Synthesis, Crystal Structure, Hirschfield surface analysis and catalytic activity of New Cobalt (II) complex of 4-Nitrobenzoic acid and 1-Methylimidazole
Mr. Sumiran Tamang – St. Joseph's College, Darjeeling

Novel cobalt (II) complex prepared by the reaction of Cobalt (II) Nitrate Hexahydrate, 4nitrobenzoic acid and 1-methyl imidazole in anhydrous ethanol under reflux conditions. Characterization of the complex has been done using different analytical and spectroscopic techniques (X-ray crystallography, FT-IR, Thermogravimetry, etc.). X-ray single crystal structure analysis of the complex revealed that it crystallizes in monoclinic I2/a space group with following parameters: a= 33.046(1) Å, b = 19.5363 (8) Å, c =15.7773 (9) Å, α = 115.176 (2) °, V = 9218.3 (8) Å^3, and Z = 4. Hirschfield surface analysis of the complex was done to analyse the intermolecular interactions present. Catalytic activity of the synthesised complex was studied in the solvent free synthesis of 2,4,5-triarylimidazole derivatives as well.



Characterizing Ion Traps for Quantum Science and Beyond
Dr. Ranjit Kumar Singh – Physikalisch Technische Bundesanstalt (PTB), Braunshweig, Germany
Ion traps serve as a cornerstone of modern quantum science, enabling precise control and manipulation of individual ions for applications spanning quantum computing to fundamental physics research. This presentation explores the principles underlying ion trapping, emphasizing the confinement of Ytterbium 172 ions through DC and RF fields, alongside the application of Doppler and sideband cooling to achieve ultra-low temperatures. Attention is also given to trap characterization techniques—such as measurements of secular frequencies, micromotion, and heating rates—that offer essential insights into trap performance and stability. These approaches are gaining significance as a critical area of study, connecting academic research with industrial innovation. Enhanced understanding of ion dynamics and trap optimization through this work supports advancements in quantum technologies and precision measurement systems, encouraging collaboration and progress across disciplines.

Transforming Mathematics Education: A Constructivist Approach to Knowledge and Learning
Dr. Dibya Gulab Minj - Holy Cross Women's College, Ambikapur

The 2005 National Curriculum Framework (NCF) has extensively discussed knowledge and learning. It proposes placing all of our perceptions and comprehensions of the learning and knowledge process in a different paradigm. The NCF acknowledges that knowledge is the result of the child's own action and that children are inherently active and natural learners. As a result, the lesson plans must foster and expand upon his creative and active qualities as well as his innate curiosity in creating and relating to other people, making sense of the world, and acting on it. The factory-model schooling of the past is drastically different from this. It implies that a new definition of the "educated person" and a fresh interpretation of the concept of "knowledge" are needed. Rather than presenting mathematics as a rigid and unchangeable set of rules to be memorized, a new approach will enable students to explore the subject as a dynamic and evolving discipline. Constructivist pedagogy moves away from traditional teacher-centered, textbook-driven, and rote learning approaches. This paper examines how teachers can foster innovation and creativity in teaching mathematics through a constructivist approach. It highlights strategies that encourage active learning, problem-solving, and critical thinking, allowing students to build their understanding. The focus is on creating engaging, student-centered lessons that promote deep conceptual comprehension.

Key Words- Constructivist pedagogy, Teacher-centered, Lesson plan, Knowledge, Natural learner

Generation Of Self-Similarity in a Metric Space
Dr. Priyam Chakraborty – St. Joseph's College, Darjeeling

Here the notion of a metric space is described as a generalization of the distance. Self-similar structures such as fractals are described. Methodology for generation of fractals in abstract spaces is established in this work. The role in understanding the structure and dynamics of complex systems and are described. Possible scopes of application and the geometric perspectives of coupled fractals are explored.

Applied AdS/CFT correspondence in strongly coupled Systems
Dr. Nishal Rai – St. Joseph's College, Darjeeling

The formation of Quark-Gluon plasma (QGP) in heavy ion colliders like the Relativistic Heavy Ion Collider (RHIC) and the Large Hadron Collider (LHC) is a complex process. In noncentralized collisions, spectator ions generate a magnetic field, leading to the Chiral Separation Effect (CSE) and transport phenomena like chiral magnetic (CME) and chiral vortical effects (CVE). To understand these phenomena, a holographic model is proposed, which is dual to a strongly coupled field theory featuring both chiral and mixed gauge-gravitational anomalies. The study aims to provide valuable insights into the process and dynamics of anomalous transport during QGP formation in non-centralized collisions.

Smart Sensors, Smarter Health: Exploring Biosensors and Bioanalytical Tools in Modern Medicine
Dr. Kuldeep Mahato – University of California, San Diego

Biosensors are transforming the landscape of healthcare by enabling rapid, sensitive, and specific detection of biomarkers crucial for disease diagnosis, monitoring, and management. At their core, biosensors combine a biorecognition element—such as enzymes, antibodies, or nucleic acids—with a transducer to convert biological interactions into measurable signals. These platforms bridge the gap between laboratory-based diagnostics and real-time health monitoring, offering significant advantages in terms of speed, portability, and user-friendliness. This talk will introduce the fundamentals of biosensor design, including the key components and transduction mechanisms (electrochemical, optical, piezoelectric, etc.), Here, we will explore how advances in materials science, nanotechnology, and microfabrication have led to next-generation biosensors with improved sensitivity, miniaturization, and integration. Special emphasis will be placed on recent innovations in point-of-care diagnostic tools, which allow immediate testing at the patient's side, reducing dependence on centralized laboratories. I will also discuss the exciting realm of wearable biosensors embedded in patches, smartwatches, or textiles for continuous monitoring of glucose, stress hormones, hydration, and more. Furthermore, the development of implantable biosensors is opening new frontiers in chronic disease management by enabling long-term in vivo monitoring and closed-loop therapeutic systems. By the end of this session, students and the audiences will gain a broad understanding of how biosensor technologies are paving the way for personalized and precision medicine, making healthcare more proactive, data-driven, and accessible—even outside traditional clinical settings.

Harnessing microbial Iron redox cycling for nutrient removal in onsite wastewater treatment systems
Dr. Risabh Shukla - University of Hawaii at Manoa, Honolulu, Hawaii, USA

Microbial iron redox cycling plays a crucial role in nutrient removal in both natural and engineered environments. In this study, we developed an innovative iron cycling biofilter with a dual zone configuration consisting of sequential anaerobic and microaerobic zones. This design harness microbial iron redox cycling for nitrogen removal from wastewater. The iron cycling biofilter was specifically designed as an alternative to cesspools in Hawaii, providing an environmentally sustainable solution for onsite wastewater treatment. We used basalt, locally available volcanic rock rich in iron as the packing material for biofilter to enhance organic and nutrient removal from wastewater. Two additional biofilters were also designed for comparison: one packed with iron-coated perlite to evaluate the effect of readily available iron on nitrogen removal, and the other with perlite as a control. Our findings demonstrated that the basalt-based biofilter supports robust microbial activity, driving iron-mediated nitrogen removal processes. During various operational stages, the basalt biofilter achieved over 90% reduction in ammonia and chemical oxygen demand (COD) concentrations and more than 60% reduction in phosphorus concentrations. Biofilm activity analyses revealed that iron-mediated nitrogen removal pathways, such as Feammox, were active in the basalt and iron-coated perlite bioreactors. In contrast, the control biofilter relied predominantly on nitrification as the primary pathway for nitrogen removal. These results highlight the potential of basalt-based biofilters as an effective and sustainable solution for nutrient removal in decentralized wastewater treatment systems, particularly in resource-limited and environmentally sensitive regions like Hawaii.

Targeting Replication Challenges to combat Drug Resistance in BRCA-1 linked cancers
Dr. Sanjeeta Tamang – University of Birmingham, UK

Individuals who inherit a pathogenic BRCA1 or BRCA2 mutations (1 in 400 people) are at high risk for cancers such as breast, ovarian, prostate, and pancreatic. Tumours in these patients typically lose the remaining wild-type gene copy. Most inherited mutations lead to nonsense-mediated decay of the transcript, resulting in no BRCA protein, while most 'second hits' remove the entire gene. BRCA1/2 are essential for DNA repair through homologous recombination (HR), and drugs that force cells to rely on HR, such as platinum-based drugs and poly-ADP-ribose-polymerase inhibitors (PARPi), are used to treat BRCA1/2-deficient cancers. However, 50-87% of BRCA-mutant cancers do not respond or eventually develop resistance to HR-directed therapies. We are investigating the HR-independent role of BRCA1 in

targeting BRCA-mutant cancers using separation-of-function mutants. We are screening for genes that support the survival of these mutants, aiming to identify specific gene pathways for drug discovery. Targeting these pathways could bypass common drug resistance in BRCA1 mutant cancers, potentially suppressing resistance and offering effective second-line therapies, thereby improving treatment outcomes for patients.

Investigation of Inclusion Complex of Gemcitabine with Beta-Cyclodextrin to decrease cytotoxicity by Experimental and Computational Approach

Dr. Antara Sharma – St. Joseph's College, Darjeeling

Most of the drugs are toxic towards normal cell and are health hazardous for all humans. At present researchers from all over the world are trying to synthesise designer drugs with diminished toxicity and adverse effects. The purpose of the present study is to enhance the bioavailability and biocompatibility of Gemcitabine (GEM) by decreasing its toxicity and reducing deamination during drug delivery through incorporating it inside the hydrophobic cavity β-cyclodextrin (β-CD) without affecting drug ability of the parent compound (GEM). The inclusion complex (IC) was characterized by different physical and spectroscopic techniques thereby confirming the successful insertion of GEM molecule into the cavity of β-CD. The molecular docking study showed that the orientation of GEM molecule into the β-CD cavity (-5.40 kcal/mol) is stable for ligand binding. Photostability studies confirmed that the inclusion of GEM using β-CD leads to stabilization of GEM (≥96%) towards light. IC (GEM-β-CD) and GEM have exhibited effective antibacterial and antiproliferative activities without being metabolized in a dose dependent manner. The CT-DNA analysis showed sufficiently strong IC (GEM-β-CD) binding ($Ka=8.1575x10^{10}$) and this interaction suggest that IC (GEM-β-CD) may interact by targeting nucleic acid in the host cell. The synthesized IC (GEM-β-CD) a derivative of GEM, has pharmaceutical potentiality and may find application in biomedical research with decreased toxicity

Exploration of Various Interactions of Some Essential Amino Acids Prevalent in Aqueous Solutions of a Neurotransmitter (TYH) for Advanced Applications in Pharmaceutical Industries by Physiochemical Methodologies

Dr. Rajani Dewan – St. Joseph's College, Darjeeling

Amino acids are fundamental components for different biologically active compounds and building blocks of protein, the physiochemical characteristics of amino acids in aqueous media have long been of interest because most biological reactions take place in these conditions. To find out different types of physiochemical interaction of two essential amino acids L-Arginine and L-Phenylalanine with drug Tyramine hydrochloride in aqueous media is the main objective of this work. In the ternary system of drug, amino acid, and aqueous media to find out the feasible intermolecular interaction of different thermodynamic properties – density, viscosity, surface tension, and electrolytic conductivity studies are performed in three different temperature and molal concentrations of the aqueous solution of TYH and derived different Physiochemical properties - apparent molar volume (Φv) limiting apparent molar volume (Φv^0), Falkenhagen coefficient (A) and viscosity B coefficient to analyze the solute-solvent interaction. The Hepler's constant ($\partial\Phi_{E^o}/\partial T$), and (dB/dt). values are evaluated to find out the structure-breaking or structure-making nature of solute (amino acids) in solvents (aqueous TYH solution). Limiting Surface tension value also suggested the mode of interaction of amino acid with aqueous solution of TYH. Proton NMR value of two amino acids and TYH of pure state and chemical shift of their mixture gives the idea of hydrophobic interaction in solution, and molecular association constant and binding energy of amino acid and TYH is obtained from the UV-visible spectra. The overall study suggested that solute–solvent interaction of the [L-Arginine and TYH] system predominates over the [L-Phenylalanine and TYH] system.

Tea Endophytes

Miss Sweta Mukhia – St. Joseph's College, Darjeeling

Endophytes refer to a variety of microorganisms that inhabit the tissues of higher plants, colonizing them without inflicting harm. These include both bacteria and fungi. They are believed to be a rich source of novel bioactive compounds, including antibiotics and anticancer agents, as well as other biological control substances. Camellia sinensis, an evergreen shrub from the Theaceae family, has its young leaves harvested for tea production. The plant sample was collected from the Sukna tea estate in Darjeeling. A total of 17 bacterial strains and 5 fungal strains were isolated from the roots, leaves, and stems of this plant. The bacteria exhibited significant growth hormone production, particularly Auxin and Gibberellins, with levels reaching 160 to 300 µg/ml and 200 to 360 µg/ml, respectively. None of the isolated strains were found to solubilize phosphorus or fix nitrogen. Additionally, the bacterial strains demonstrated antimicrobial properties against human pathogens like Escherichia coli, Vibrio cholerae, and Klebsiella sp., as well as Pseudomonas aeruginosa, Acinetobacter baumannii, and Burkholderia cepacia. The fungal genera also displayed some amylolytic and proteolytic activity. This study indicates that these microbes possess significant potential for synthesizing numerous novel compounds that could be utilized in pharmaceuticals, agriculture, and other industries.

Keywords: Tea , Endophytes, Auxin, Gibberellin, Antimicrobials

DCLK1 As A Stem Cell Marker For Cancer Progression And Metastasis

Miss Dibyashree Chhetri – St. Joseph's College, Darjeeling

Doublecortin-like kinase (DCLK-1) is the microtubule-associated kinase protein noted to be a novel cancer stern cell (CSC) marker. Due to overexpression of DCLK1 in gastric cancer (GC), human colon cancer cells (hCCs), pancreatic

cancer (PC), renal cancer, and other cancers, it is widely being used as a CSC marker. DCLK1 in correlation with several stem cell receptors, signaling pathways, and tumor suppressor gene and onco gene, play a vital role in various cancer-cell proliferation, stemness, tumor initiation, growth, progression and metastasis. Studies show that successful targeting of DCLK1 results in inhibition of tumor cell proliferation and neoplastic cell arrest suggesting it to have a direct or indirect role in promoting tumorigenesis. A study based on solid cancers and head and neck cancer lymph metastasis revealed DCLK1 to be an independent marker for reoccurrence. Despite being characterized as one of the most specific markers for colorectal cancer (CRC), the role of DCLK1 in bladder cancer (BC) is less explored and reported. Increased DCLK1 expression also correlates with poor prognosis and survival rates making cancer progression and metastasis a vital cause of cancer-related death. Embracing targeted technologies like the use of siRNA, miRNA, CRISPR Cas 9 technology, nano molecules, specific mAbs, and silencing the pathways regulated by DCLK1 has shown promising results both in vitro and in vivo. Moreover, DCLK1's mechanism on the remodeling tumor microenvironment (TM), anti-cancer therapies, and immuno-therapies are potential CSC targets for preventing and minimizing deaths due to cancer progression, metastasis and relapse. Keywords: Double-cortin like kinase (DCLK-1), cancer stern cell (CSC), intestinal tuft cells (TC), epithelial-mesenchymal transition (EMT), colorectal cancer (CRC), tumor microenvironment (TM)

DFT, Molecular Docking and Pharmacokinetic study of some selected 2, 4, 5-triarylimidazole derivatives

Dr. Dhiraj Brahman – St. Joseph's College, Darjeeling

A series of six 2, 4, 5-triarylimidazole (IM-1 to IM-6) have been prepared by the multi-component condensation reaction of benzil, substituted salicylaldehyde and ammonium acetate under solvent free condition utilizing inexpensive and unconventional CuB_4O_7 catalyst. The synthesized 2, 4, 5-triarylimidazole derivatives have been characterized by different analytical and spectroscopic techniques. Furthermore, DFT studies such as optimization of gas phase structure, HOMO-LUMO energies, Molecular electrostatic potential, nonlinear optical properties of the synthesized compounds have been investigated. In-silico molecular docking study of the synthesized 2, 4, 5-triarylimidazole derivatives (IM-1 to IM-6) have been carried out to ascertain the inhibitory potential of these molecules against the diabetic protein (PDB ID 1IR3). The molecular docking study showed that the studied compounds have significant inhibitory potential against the protein 1IR3 and the binding energy (ΔG) values of the compounds (IM-1 to IM-6) against the protein 1IR3 found to be -8.7 Kcal/mole, -8.4 Kcal/mole, -8.8 Kcal/mole, -8.0 Kcal/mole, -8.9 Kcal/mole and -7.8 Kcal/mole respectively. in addition, the pharmacokinetic properties (ADME) of the compounds (IM-1 to IM-6) have also been studied.

Key words: 2, 4, 5-triarylimidazole, FT-IR, ^{1}H NMR, DFT, HOMO-LUMO, MEP, nonlinear optical properties, Molecular docking, Lipinski rule, Pharmacokinetic (ADME) study.

Diversity and Habitat Preferences of Black Crested Bulbul (*Rubigula flaviventris*) in the Temperate Forest of Darjeeling Himalaya

Mrs. Albina Subba – St. Joseph's College, Darjeeling

The temperate forests of Darjeeling Himalaya, part of the Eastern Himalayan Biodiversity Hotspot, support a diverse range of avian species, yet detailed studies on their habitat preferences remain scarce. This study examines Avian Diversity in the region, with a focus on Black Crested Bulbul (*Rubigula flaviventris)* and its associated species, to assess habitat utilization, species interactions, and conservation challenges. Field surveys conducted in Tiger Hill Forest (2250-2590 m a.s.l) recorded a variety of resident and migratory birds, indicating the ecological significance of this habitat. However, challenges such as limited prior records of *Rubigula flaviventris* at this altitude, habitat fragmentation, and the impact of climate change pose uncertainties for long-term species survival. Additionally, the lack of comprehensive bioacoustic data complicates monitoring efforts. Despite these challenges, this study presents opportunities for advancing ornithological research through long-term biodiversity assessments, community based conservation initiatives, and the application of modern monitoring tools such as bioacoustics and citizen science platforms. By addressing these gaps, this research aims to contribute to a broader understanding of Himalayan avian ecology and inform conservation strategies for the region's bird populations.
Keywords: Temperate forest, Conservation, Biodiversity assessments, Avian species

Induction of Apoptotic Cell Death by Beavurecin, an Active Component of the Fungus *Cordyceps tenuipes*, in Human Cervical HeLa Cells

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Beavurecin is a cyclic hexadepsipeptide that contains three D-hydroxy-isovaleryl and three N-methyl-phenylalanyl residues in an alternating sequence and is one of the active components extracted from fungi of genus *Cordyceps*, and has demonstrated to have many pharmacological activities. In this study, we investigated the effects of beavurecin isolated from *Cordyceps tenuipes* of Darjeeling-Himalaya using Sephadex LH-20 Column on proliferation and apoptosis of human cervical cancer HeLa cells, and its possible mechanism of action. Treatment of beavurecin resulted in significant decrease in cell viability of HeLa cells in a concentration-dependent manner in MTT assay. A quantitative concentration-dependent apoptotic cell death was also measured by agarose gel electrophoresis, flow cytometery

analysis using PI staining and colony formation by clonogenic assay. Biochemical studies of apoptosis unravelled beavurecin treatment resulted in an enhanced production of reactive oxygen species (ROS) and malondialdehyde, leading to an increase oxidative stress, which causes cell to undergo apoptosis thereby exhibiting its anti-proliferative properties. The recorded IC_{50} value was 3.90±0.55 µg/ml in HeLa cells using MTT assay. The percentages of HeLa cells undergoing apoptosis following treatment with 0, 1, 3, 10, 30 and 100 µg/mL methanol extracts (including the early and late apoptotic cells) were 3.54±1.22, 7.09±3.73, 6.52±3.47, 8.86±4.36, 17.365±7.99 and 42.205±19.03% respectively as compared to 3.5% (early apoptotic+ late apoptotic population) in vehicle negative cells control. Densitometry analysis of no of colonies in each well with different doses of extracts of *Cordyceps tenuipes* was calculated by using Image J software and the colony numbers in the methanolic extract treated cells were reduced by over >99% at 100µg/ml in a dose dependent manner. Taken together, these findings indicate that beavurecin induces apoptosis in HeLa cells through regulation of multiple apoptotic pathways thereby sharply decreasing the colony forming ability of the tested cells. Although further mechanical studies are much needed, our results in the present investigation revealed that beavurecin could be regarded as a new effective and chemotherapeutic compound for human cervical cancer treatment.

Key words: HeLa cells, apoptosis, flow cytometery, Cordyceps, beavurecin, Darjeeling-Himalaya

A Brief Overview of Microplastic Pollution and Its Impact on Seabird Populations

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Since the mid-20th century, the exponential increase in plastic production has led to widespread environmental contamination, with microplastics (MPs, <5 mm) and nanoplastics (NPs, <1 µm) emerging as persistent and pervasive pollutants. These particles infiltrate ecosystems from urban zones to the most remote habitats on Earth—including polar regions, the Mariana Trench, and Mount Everest. Of particular concern is their impact on marine life, especially seabirds, which ingest plastic debris directly or indirectly through contaminated prey. Once ingested, these plastics induce serious physiological disturbances such as gastrointestinal blockages, reduced nutrient absorption, oxidative stress, hormonal imbalances, and reproductive failure. Additionally, MPs act as vectors for toxic substances including heavy metals, PCBs, and endocrine-disrupting chemicals, compounding their deleterious effects.

Current research estimates that by 2050, nearly all seabird species will have ingested plastic. Alarmingly, microplastics have already been detected in the feathers, digestive systems, and feces of numerous seabird species. Their ingestion not only affects individual health but also facilitates the spread of contaminants across marine ecosystems through regurgitation and excretion. This paper highlights recent scientific findings on microplastic toxicity, their mechanisms of action in avian physiology, and case studies involving species such as northern fulmars, shearwaters, and gulls.

To mitigate this escalating crisis, the review emphasizes the importance of integrated approaches combining scientific research, public awareness, policy reforms, and improved waste management. Strategies such as banning single-use plastics, enhancing recycling infrastructure, and enforcing international agreements are crucial. Furthermore, long-term ecological monitoring and toxicological studies on seabirds can offer deeper insights into the chronic effects of microplastics and inform conservation policies.

Keywords: Microplastics, Seabirds, Marine pollution, Toxicity, Endocrine disruption, Plastic ingestion, Conservation strategies

Monitoring the vulnerable Asian Small-Clawed Otter Populations and Combating Poaching through Stakeholder Participation in the temperate forest of Darjeeling District.

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Otters are ambassadors of wetland ecosystems and they are obligatorily tied to aquatic environments and occupy littoral areas of both freshwater and marine habitats throughout much of the world. They are classified in the Lutrinae, one of the subfamilies that belong to the Mustelidae. However, otters are widely distributed and play a vital role in the wetland ecosystem as a top carnivore species, not much attention has been given to understand their ecology in the Darjeeling Hills. They are suitable indicators of the health of a wetland ecosystem as they are sensitive to degradation along the food chain. Of the five species found in Asia, Asian small-clawed otter *(Aonyx cinereus)* is found in Darjeeling hills. Close examination of their tracks, body size and weight, snout and their diet analysis from spraints along with the location of the spraints can be helpful in determining the identity of the otter species. They are predominant fish eaters preferring to feed on fish 10-15 cm long. They are crepuscular wherein their activity is high during dawn and dusk. Our studies in the temperate and riverine forest of Darjeeling district have revealed that small-clawed otter prefer areas that are slightly rocky with shoreline vegetation in a perennial aquatic ecosystem. Spraints analysis revealed that they are also found living in human modified landscapes to the ones found in natural habitats. They are social in their behaviour and are known to occur in large groups of up to six individuals. Major threats to otter survival are the loss of wetland habitats, reduction in prey biomass and pollution and poaching. As top predators in freshwater and wetland ecosystems, the loss of resident otter populations has a profound negative impact on the local food webs and habitat relationships. In this light, we are also working with local stakeholders to develop monitoring methods and resources and are continuing to engage with them to sensitise them on the role otters play in the ecosystem. In addition, we are also educating the local people in minimising the conflict with fisher folk and their perceptions towards otters. Further ecological studies are being initiated to determine habitat requirements of this vulnerable species. The presentation will focus on the multiple roles of local stakeholders in understanding and management of fish population in the region and a need for long term demographic monitoring of temperate freshwater fishes and other crustaceans with an aim to formulate ecologically meaningful management recommendations of otter in near future.

Key Words: Asian Small-Clawed Otter, temperate, Darjeeling, crepuscular