ABSTRACT BOOK

ONE DAY INTERNATIONAL SEMINAR (HYBRID MODE)

PROMOTING TEACHING & RESEARCH IN CONTEMPORARY SCIENCE & ENGINEERING FOR SUSTAINABLE DEVELOPMENT GOALS

2026

ORGANIZED BY:

INTERNAL QUALITY ASSURANCE CELL,SEMINAR COMMITTEE & DEPARTMENT OF MOLECULAR BIOLOGY & BIOTECHNOLOGY, SRIPAT SINGH COLLEGE

&

INDIAN PHOTOBIOLOGY SOCIETY, KOLKATA, WEST BENGAL, INDIA

IN COLLABORATION WITH

DUMKAL COLLEGE, MURSHIDABAD,
DR. SUDHIR CHANDRA SUR INSTITUTE OF TECHNOLOGY & SPORTS COMPLEX, KOLKATA &
SAGARDIGHI KAMADA KINKAR SMRITI MAHAVIDYALAYA, SAGARDIGHI, WEST BENGAL, INDIA

Published by
Sripat Singh College

Venue:Rabindra Sabhakaksha
Sripat Singh College
Time: 10.00 a.m.

Abstract Book

of

International Seminar on Promoting Teaching & Research in Contemporary Science & Engineering for Sustainable Development Goals

Edited By

Dr. Sudhanshu Kr. Biswas, Dr. Abhishek Basu, Dr. Sagar Simlandy and Dr. Debjani Mandal

ISBN: 978-81-971971-6-1

Published on 21.02.2026

Published By

Dr. Kamal Krishna Sarkar

Principal, Sripat Singh College

e-mail: sscollege2009@gmail.com

Website: https://www.sripatsinghcollege.edu.in/

International Seminar (Hybrid Mode)

Promoting Teaching & Research in Contemporary Science & Engineering for Sustainable Development Goals

February 21, 2026 (Saturday)

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About The Host Institute

Sripat Singh College was established in 1949 by the illustrious Jamindar Sripat Singh Dugar ji, driven by his visionary commitment to advancing higher education in the then-educationally backward district of Murshidabad. Originally affiliated with the University of Calcutta, the college now operates under the academic jurisdiction of the University of Kalyani. Over the course of its distinguished 77-year history, Sripat Singh College has evolved into a premier institution of higher learning and research. It offers undergraduate programs across the disciplines of Science and Humanities, along with a postgraduate program in Bengali. Renowned for its academic excellence, the college is supported by a team of highly qualified and dedicated faculty members, many of whom are distinguished scholars and researchers in their respective fields. The institution takes pride in its alumni, who have earned placements and recognition in esteemed national and international institutions. Sripat Singh College continues to uphold its founding ideals, fostering intellectual growth, critical thinking, and academic rigor among its students.

About Indian Photobiology Society

The Indian Photobiology Society (IPS) was initiated in 1964 as the Indian Photobiology Group and registered in 1970 in its present name. The founder Secretary of IPS was Prof. K. K. Rohatgi-Mukherjee. IPS celebrated its Diamond Jubilee (60th anniversary) in January 2023 through various scientific activities like students' competitions, popularisation of science through seminars, conferences in different colleges and higher learning institutes, etc. The Society follows the common guideline of the scientific organization by promoting research integrity, convening conferences, and seminars, and publishing research-related newsletters, books or journals, etc. For fostering responsible research practices the Executive Council has started Monthly 'IPS Science Talk' that was inaugurated by Prof. Nitin Chattopadhyay, President, IPS.

Resource Persons

- **Prof. Chittaranjan Sinha, Professor, Department of Chemistry, Jadavpur University, West Bengal, India**
- **Prof. Tapas Kumar Bandyopadhyay, Professor, Department of Molecular Biology and Biotechnology, University of Kalyani**
- **Prof. Bimal Krishna Banik, Professor, Department of Natural Sciences & Human Studies, Prince Mohammad Bin Fahd University, Kingdom of Saudi Arabia**
- **Dr. Md Raihan Uddin, Assistant Professor & Head, Department of Biotechnology & Physiology (P.G.), Raja Narendra Lal Khan Women's College (Autonomous), Midnapore**

SRIPAT SINGH COLLEGE

[NAAC ACCREDITED at B grade (3rd. Cycle, 2024)]
P.O. Jiaganj, Dist. Murshidabad, West Bengal, PIN 742 123
Web: https://www.sripat singhcollege.edu.in/e-mail:sscollege2009@gmail.com

Memo No: *Dated:*

It is with immense pleasure and great pride that I extend my warmest greetings to all participants, scholars, researchers, educators, and distinguished guests attending the International Seminar on "Promoting Teaching & Research in Contemporary Science & Engineering for Sustainable Development Goals" scheduled for February 21, 2026, at Sripat Singh College.

This prestigious event, organized by the IQAC, Seminar Committee, and Department of Molecular Biology & Biotechnology of our esteemed institution, in collaboration with Sagardighi Kamada Kinkar Smriti Mahavidyalaya, Dr. Sudhir Chandra Sur Institute of Technology & Sports Complex, and Dumkal College, exemplifies our unwavering commitment to fostering excellence in education and groundbreaking research. By aligning our efforts with the United Nations Sustainable Development Goals, we aim to address pressing global challenges through innovative approaches in contemporary science and engineering. The abstracts compiled in this book represent a rich tapestry of innovative ideas, cutting-edge research, and forward-thinking perspectives from experts across diverse fields. These contributions not only highlight the potential of interdisciplinary collaboration but also pave the way for practical solutions that drive sustainable progress and societal well-being.

I commend each contributor for their dedication and insightful work, and I urge all attendees to engage in vibrant discussions, forge meaningful partnerships, and exchange knowledge that will shape the future. Together, let us harness the power of science and education to build a brighter, more resilient, and sustainable world.

Shaoni Singha Roy

SHAONI SINGHA ROY
President
Governing Body
Sripat Singh College
Jiaganj, Murshidabad

SRIPAT SINGH COLLEGE

[NAAC ACCREDITED at B grade (3rd. Cycle, 2024)]
P.O. Jiaganj, Dist. Murshidabad, West Bengal, PIN 742 123
Web: https://www.sripat singhcollege.edu.in/e-mail:sscollege2009@gmail.com

Memo No: *Dated:*

It is a distinguished honor and a privilege to welcome the global academic community to this International Seminar titled "Promoting Teaching & Research in Contemporary Science & Engineering for Sustainable Development Goals." This momentous occasion is organized by Sripat Singh College in association with the Indian Photobiology Society, and in formal collaboration with Dumkal College, Dr. Sudhir Chandra Sur Institute of Technology & Sports Complex, and Sagardighi Kamada Kinkar Smriti Mahavidyalaya.

In the contemporary era, the confluence of scientific rigor and engineering innovation is paramount to addressing the multifaceted challenges of global sustainability. This seminar is meticulously designed to deliberate upon the pivotal role of pedagogy and advanced research in achieving the United Nations Sustainable Development Goals (SDGs). The selected themes of this seminar provide a comprehensive overview of the current scientific landscape, focusing on the integration of green technologies, the exploration of light-matter interactions within the chemical and biological sciences, and the implementation of digital advancements in resource management. By examining these diverse yet interconnected fields, the seminar aims to underscore how modern science and engineering can be harmonized to create sustainable ecological and societal frameworks.

I extend my profound gratitude and sincere commendation to the Indian Photobiology Society for their invaluable partnership. I also wish to express my deepest appreciation to our collaborating institutions—Dumkal College, Dr. Sudhir Chandra Sur Institute of Technology & Sports Complex, and Sagardighi Kamada Kinkar Smriti Mahavidyalaya—for their steadfast commitment to academic excellence.

May this seminar serve as a catalyst for transformative scientific progress and foster a spirit of global cooperation.

20.02.26

Dr. Kamal Krishna Sarkar
Principal
Sripat Singh College

DR. KAMAL KRISHNA SARKAR
Principal
Sripat Singh College
Jiaganj, Murshidabad

INDIAN PHOTOBIOLOGY SOCIETY

(Regd. No. : S/10422)

(Affiliated to the Association Internationale de Photobiologie)

Department of Chemistry, Jadavpur University, Kolkata 700 032

President: Prof. Ashok Kumar Mishra Secretary: Prof. Chittaranjan Sinha

www.ipbsindia.in/ <indianphotobiology@gmail.com>

MESSAGE

It gives me immense pleasure to learn that Sripat Singh College continues to foster its rich heritage of promoting science and culture among students and other stakeholders of the institution in particular, and society at large, by organizing the One-Day International Conference on "***Promoting Teaching and Research in Contemporary Science and Engineering for Sustainable Development Goals***" on 21st February 2026. On behalf of the Indian Photobiology Society, I congratulate the organizers and extend a warm welcome to all distinguished speakers, researchers, academicians, industry experts, and students participating in this conference.

This conference aims to offer a dynamic platform for intellectual exchange, nurturing innovative ideas and interdisciplinary collaborations affiliated with the United Nations Sustainable Development Goals (SDGs). In the rapidly evolving landscape of science and engineering, it is imperative that education and research not only advance knowledge but also address global challenges related to health, energy, environment, and sustainable technologies. Through meaningful discussions, knowledge sharing, and strategic partnerships, we aspire to strengthen academia–industry linkages and inspire young researchers to contribute toward sustainable and inclusive development.

I sincerely thank the organizing committee, collaborators, and participants for their dedicated efforts and valuable contributions in making this conference a significant step toward a resilient and sustainable future.

Best wishes

Professor of Chemistry
Department of Chemistry
Jadavpur University
Kolkata-700 032

(Chittaranjan Sinha), 14/02/2026

☎ 9153549620
✉ dumkalcollege@gmail.com

DUMKAL COLLEGE

P.O- Basantapur, P.S- Dumkal, Dist.- Murshidabad, West Bengal, Pin- 742406
(Govt. Aided, Affiliated to the: University of Kalyani Included under section 2(f) & 12 (B) of UGC Act.)

Ref:……. **18-02-2026**

Message from the Principal, Dumkal College

It is with immense pleasure that I extend my best wishes to the organizing team of Sripat Singh College, the Indian Photobiology Society, and all our esteemed collaborating institutions on the occasion of this **National Science Day Celebration** for conceptualizing the **One-Day International Seminar** on "**Promoting Teaching & Research in Contemporary Science & Engineering for Sustainable Development Goals"**, scheduled for February 21, 2026.

As Principal of Dumkal College, one of proud collaborating institutions, I am delighted to endorse this timely initiative that promises to inspire meaningful dialogue and foster active learning among academicians, researchers, and students (both onsite and online), and generate actionable knowledge toward global sustainability.

Best wishes for a grand success!

Dr. Bhabesh Pramanik

Principal
Dumkal College
Basantapur, Murshidabad

Sur Tech

DR. SUDHIR CHANDRA SUR INSTITUTE OF TECHNOLOGY AND SPORTS COMPLEX

(Autonomous Institute & affiliated to MAKAUT, WB, NAAC accredited with Grade "A")

540 Dum Dum Road, Surermath, (Near Dum Dum Jn. Station), Kolkata-700074
Phone: +91 33 25603889, 25603898, 65330375
Website: www.surtech.edu.in, Email: info@dsec.ac.in

Date:17/02/2026

Message

It gives me immense pleasure to extend my warm greetings on the occasion of the **National Science Day Celebration and One-Day International Seminar (Hybrid Mode) on "Promoting Teaching & Research in Contemporary Science & Engineering for Sustainable Development Goals"** to be held on **21 February 2026**.

As the Principal of Dr. Sudhir Chandra Sur Institute of Technology and Sports Complex (SurTech) and as a Patron and collaborating partner of this academic initiative, I strongly believe that meaningful progress in science and engineering can only be achieved through collective intellectual engagement. Platforms such as this seminar play a vital role in bringing together academicians, researchers, students, and industry experts to exchange ideas, share innovations, and address global challenges aligned with the Sustainable Development Goals.

In the present era, interdisciplinary research, ethical technological advancement, and socially responsible innovation are essential to build a sustainable future. This seminar provides a valuable opportunity to promote scientific temperament, encourage collaborative research, and inspire young minds to contribute towards solutions in energy, environment, healthcare, and emerging technologies.

I congratulate the organizers: IQAC, Seminar Committee, Department of Molecular Biology & Biotechnology of Sripat Singh College, and the Indian Photobiology Society, for their commendable effort in arranging this important academic event. I am confident that the deliberations and interactions during this seminar will foster knowledge exchange, strengthen academic partnerships, and motivate participants to pursue impactful research.

I wish the seminar great success and extend my best wishes to all participants for fruitful discussions and enriching academic interactions.

Prof. (Dr.) Saradindu Panda
Principal
Dr. Sudhir Chandra Sur Institute of Technology and Sports Complex (SurTech)
(Autonomous Institution), Dum Dum, Kolkata

PRINCIPAL
Dr. Sudhir Chandra Sur Institute of Technology & Sports Complex
540, Dum Dum Rd. Kolkata-74

Phone : 03483-268966

Sagardighi Kamada Kinkar Smriti Mahavidyalaya

(Govt.-Aided & Affiliated to University of Kalyani, NAAC Accredited)

P.O. & P.S. – Sagardighi ✡ (Near B.D.O. Office) ✡ Dist. – Murshidabad

Pin.- 742226 ✡ West Bengal

e-mail ID : sdg.mahavidyalaya@gmail.com ✡ Website : www.skksm.ac.in

Estd : 2008

College Memo No. : ***Date : 18.02.2026***

MESSAGE

National Science Day is celebrated every year to commemorate the discovery of the **Raman Effect** by the great Indian physicist **C. V. Raman was** awarded the Nobel Prize in Physics in 1930 for his ingenious discovery. This celebration reminds us to develop scientific temper, curiosity and innovative thinking.

Science and Technology play a crucial role in achieving sustainable national development. In today's rapidly changing world, nations cannot progress without innovation, research, and technological advancement. Sustainable development ensures that we meet the needs of the present without compromising the ability of future generations to meet their own needs.

The concept of sustainable development was globally recognized at the United Nations through the adoption of the 17 Sustainable Development Goals (SDGs) in **2015**. These 17 goals mainly focus on poverty eradication, quality education, clean energy, climate action, and protecting the environment and promoting equality to create a healthier, peaceful, prosperous and sustainable world by the year **2030**.

Each of us has a role to play. It is not just a government responsibility- it's our shared duty. By conserving water, saving energy, planting trees, reducing plastic use, promoting education and spreading awareness among ourselves. Science and Technology play a vital role in our everyday lives, from electricity to mobile phones, from medicines to space research, it makes our life comfortable and progressive.

SDGs rely heavily on chemical science and innovation. Chemistry is not confined to laboratories; it plays a vital role in shaping a sustainable and resilient future. Being a chemist, I cannot remain silent when discussing the Sustainable Development Goals. From clean water to renewable energy, from climate action to responsible consumption, chemistry stands at the heart of sustainable development. **Green chemistry** focuses on designing chemical products and processes that reduce or eliminate hazardous substances. This approach supports cleaner industries and safer environments. Chemists may contribute to renewable energy development through: Solar cell materials, Hydrogen fuel technology, Battery innovation, and Biofuels. Thus advances in chemical research help to improve energy efficiency and reduce carbon emissions to achieve SDG 7. Chemists may support agriculture by developing: Eco-friendly fertilizers, Safer pesticides, Soil testing techniques. These innovations definitely will increase crop yield while minimizing environmental damage. Medicinal chemistry leads to the discovery of new drugs and vaccines, improving public health and supporting SDG 3. Chemists may focus on enabling recycling technologies and the design of sustainable materials that can be reused, reducing resource depletion.

We hope this National Science Day Celebration and One-Day International Seminar which is being organized by **Sripat Singh College**, Murshidabad and Indian Photobiology Society, Kolkata, in Collaboration with Dumkal College, Murshidabad, Dr. Sudhir Chandra Sur Institute of Technology & Sports Complex, Kolkata, Sagardighi Kamada Kinkar Smriti Mahavidyalaya, Sagardighi, West Bengal, India, on -

"Promoting Teaching & Research in Contemporary Science & Engineering for Sustainable Development Goals" will hopefully give insight on how Science and Engineering may contribute to sustainable national development through Agricultural Advancement, Renewable Energy Development, Healthcare Improvement, Industrial Growth and Innovation, Environmental Protection, and/or Digital Transformation.

The program will inspire the participants to develop scientific and sustainable thinking - To eradicate poverty and hunger, To protect the planet from environmental degradation, To ensure prosperity and equality, To promote peace and global partnership.

By promoting innovation, investing in research, and applying scientific knowledge responsibly, nations can achieve economic progress, social equity, and environmental protection together. Let us pledge to work together for a better and sustainable future. Together, with dedication and teamwork, we can make this seminar a grand success.

Principal
Sagardighi K.K.S. Mahavidyalaya
Sagardighi, Murshidabad

University of Kalyani

FACULTY OF SCIENCE

Department of Molecular Biology and Biotechnology

Dr. Tapas. K. Bandyopadhyay
Professor & Head

KALYANI 741235, West Bengal
Tel.: 2582-8378, Ext.-344
9433164044 (Cell)
Fax: 033-2582-8282
Email: tapas@klyuniv.ac.in

Message

I am truly privileged and honoured to express my gratitude and wish well on the auspicious occasion of the International Conference on **'Promoting Teaching & Research in Contemporary Science & Engineering for Sustainable Development Goals'** jointly organised by IQAC, Seminar Committee, and Department of Molecular Biology & Biotechnology, Sripat Singh College, Murshidabad, and Indian Photobiology Society, Kolkata, West Bengal, India.

As the global community stands at a critical juncture, the 2030 Agenda for Sustainable Development Goals (SDGs) serves as our shared blueprint for peace and prosperity. However, achieving these goals is impossible without the rigorous application of science and the innovative spirit of engineering. By hosting this international forum, Sripat Singh College is not merely conducting an academic exercise; it is fostering a vital ecosystem where pedagogy meets purpose.

This conference theme is particularly timely. The integration of "Contemporary Science" with "Sustainable Development" highlights the need for research that is not just theoretically sound but practically impactful. Whether it is through clean energy solutions, sustainable agriculture, or advancements in healthcare technology, the academic contributions emerging from this gathering have the potential to shape the future of West Bengal and the world. The synergy between "Teaching" and "Research" mentioned in the title is also commendable. True sustainability begins in the classroom. By refining how we teach contemporary science, we empower the next generation of engineers and scientists to view their work through the lens of ethical responsibility and environmental stewardship.

I would like to extend my heartiest congratulations to the Principal, Dr. Kamal Krishna Sarkar, the Organizing Committee, and the entire faculty of Sripat Singh College. Since its inception in 1949, this institution has been a cornerstone of higher education in Murshidabad. By inviting global scholars to deliberate on these pressing issues, the college continues its legacy of excellence under the affiliation of the University of Kalyani.

I wish the organizers a seamless and successful event. May this conference be a landmark success, leaving a lasting imprint on the academic landscape of India and providing a clear roadmap for a greener, more equitable future.

Success to all participants and long live the spirit of scientific inquiry!

Tapas Kumar Bandyopadhyay

Message from the Resource Person
Science Motivational Program
Promoting Teaching & Research in
Contemporary Science & Engineering for Sustainable Development Goals
Sripat Singh College, Jiaganj
Murshidabad, West Bengal
India

Dear ALL:

As the Resource Person, it gives me immense pleasure to welcome all of you at the International Conference on "Promoting Teaching & Research in Contemporary Science & Engineering for Sustainable Development Goals" which is being organized by Sripat Singh College and Indian Photobiology Society on February 21, 2026. This novel program is devoted to offering an outstanding forum for all students and researchers working on diverse basic and applied sciences to interact with others. This helps to discover significant opportunities for creative scientific results intended for the benefits of mankind protecting the surroundings through green principles. The committee of this conference has worked very hard to identify a unique scientific and engineering program that focuses on valuable sustainable methods. I believe many lectures will be given by renowned researchers at this conference. In addition, the young researchers and students will share their findings and ideas on this topic. The deliberations will assist to learn diverse branches of science, engineering and technology.

The new science on sustainable development will create interests by exchanging concepts and exploring interdisciplinary science as well. Hope this conference becomes highly successful in all areas of higher research and education. I welcome all of you to this valuable and crucial scientific endeavor and I am sure this conference will prove to be inspiring for all of us.

Thanks for your participation. Best regards.

Bimal Krishna Banik, Ph.D., C.Chem., F.R.S.C., F.I.C.S., F.I.S.R.O.S.E.T., F.R.S.C.S., F.I.C., Gold Medalist;
Professor, Prince Mohammad Bin Fahd University, Kingdom of Saudi Arabia;
Former: Tenured Full Professor and First President's Distinguished Professor, University of Texas, USA;
Former: Vice President of Research & Education Development, Community Health Systems of Texas, USA;
Designated as a "Distinguished Scientist" and "Distinguished Researcher".

Message from Organizing Secretaries

As the Organizing Secretaries, it is our privilege to invite you to the International Seminar on "Promoting Teaching & Research in Contemporary Science & Engineering for Sustainable Development Goals" at Sripat Singh College. This event marks a vital effort to align our academic pursuits with the global mission for a sustainable future.

The 21st century demands that science and engineering transcend traditional boundaries. The United Nations Sustainable Development Goals (SDGs) serve as our roadmap, requiring a fundamental shift in how we educate and innovate. This seminar provides a dedicated forum to explore how contemporary research and pedagogical strategies can directly address environmental and social challenges.

At Sripat Singh College, we believe that the laboratory and the classroom are the starting points for global change. Our objective is to foster a dialogue where technical excellence meets ethical responsibility. We invite you to contribute your insights to this essential discourse, ensuring that the progress of today does not compromise the world of tomorrow.

We look forward to your participation in this significant intellectual journey.

Warm regards,

Dr. Sagar Simlandy

&

Dr. Debjani Mandal

Organizing Secretaries

International Seminar-PTRCSESDG-2026

Sripat Singh College

Message from Convener

It gives me immense pleasure to welcome you to the International Seminar titled "Promoting Teaching & Research in Contemporary Science & Engineering for Sustainable Development Goals," hosted by Sripat Singh College. This seminar is born out of a critical necessity to align our academic pursuits with the global urgency for a more sustainable and equitable future.

In the current era, the definition of progress is undergoing a fundamental shift. No longer is scientific advancement measured solely by technological prowess; it is now weighed against its capacity to preserve our planet and uplift society. As the convener, I believe that the academic community holds a sacred responsibility to act as the vanguard of this transition.

By organizing this international seminar, we aim to create a space where the intersection of science, engineering, and sustainability is explored with depth and rigor. We recognize that "Contemporary Science" is not a static field but a dynamic force that must be harnessed to solve real-world problems. This event is more than a formal meeting; it is a call to action for every researcher and academician to ensure that their work contributes to the global roadmap for sustainability.

We invite you to join us in this intellectual journey at Sripat Singh College. Your presence and your intellectual contributions will be the catalyst for the change we wish to see in the scientific community. Together, let us redefine the role of contemporary science and engineering as the ultimate tools for a sustainable and resilient world.

With warm regards and anticipation,

Dr. Abhishek Basu

&

Dr. Sudhanshu Kumar Biswas

Convener,

International Seminar PTRCSESDG-2026

Sripat Singh College

CONTENT

Water Crisis & Management: The Key to Sustainable Development Strategy

Chittaranjan Sinha

Professor, Department of Chemistry, Jadavpur University, Kolkata – 700 032
Secretary, Indian Photobiology Society, Kolkata
E-mail: crsjuchem@gmail.com

Abstract:

Water is the integral part of life and ecosystem. The global water crisis appears in the heart of sustainable development in the 21st century that is driven by population growth, rapid urbanization, industrial expansion, agricultural intensification, pollution, and climate change. More than 2 billion people are facing access to safe drinking water. Only 2.5% Freshwater is available on Earth and out of it ~30% is groundwater and <1% is surface water for use. The Sustainable Development Goals (SDGs), adopted by the United Nations in 2015, highlight the water crisis in SDG 6 (*Clean Water and Sanitation*) directly, and indirectly in SDG 3 (Good Health and Well-being), SDG 3 (Climate action), SDG 14 (Life below water), SDG 15 (Life on Land).

Water scarcity is related to water quality and water business towards the '*Water Wars*'. Climate change impacts on crop yield, droughts, floods, water stress, food crisis and the social unrest. Sustainable water management is fundamental to public health, ecosystem stability, and the long-term survival of civilization. Water acts as a natural carrier of soluble salts and ions that are essential for biological systems, while imbalances in their concentration can lead to adverse health effects. The use of metals and inorganic salts for therapeutic purposes has been documented in India since ancient times. Biological processes are regulated by molecules and ions at cellular and subcellular levels, where their optimal concentration governs biochemical efficiency and overall health. In this context, chemosensors have emerged as effective tools for the selective and sensitive detection of biologically and environmentally relevant ions. Our recent work focuses on the development of fluorophoric receptors and their metal complexes capable of spectrofluorometric ion/molecule detection through modulation of emission wavelength or intensity. Several newly designed molecular systems exhibit high sensitivity toward $Fe^{2+/3+}$, Zn^{2+}, Cu^{2+}, Al^{3+}, Mg^{2+}, Cr^{3+}, Cd^{2+}, Pd^{2+}, PO_4^{3-}, AsO_3^{3-}, CN^-, and F^- ions. Selected results demonstrating their relevance to water quality monitoring and sustainable health assessment will be presented.

Synthesis of Anticancer Beta-Lactams and Their Targets

Bimal Krishna Banik
(Professor)

Deanship of Research Development, Prince Mohammad Bin Fahd University, Kingdom of Saudi Arabia; Former: Full Professor & President's Distinguished Professor, Science & Engineering, University of Texas, USA; Former: Vice President of Research & Education Development, Community Health Systems of Texas, USA; Designated as "Distinguished Researcher" and "Distinguished Scientist"
E-mail: bimalbanik10@gmail.com

Abstract:

Many β-lactams are used as crucial antibiotics. We hypothesized that suitably designed β-lactams may have anticancer activity. To test the hypothesis, synthesis of new β-lactams derived from polyaromatic compounds is conducted. Diastereoselectivity and enantioselectivity of these methods are investigated.1, 2An unprecedented stereoselectivity of the β-lactam formation is observed. The mechanism of these reactions is investigated.

The new β-lactams are tested against numerous human cancer cells in vitro and in vivo. Notably, the anticancer activity of a few compounds is found superior to that of clinically active drugs. Selective differences in cytotoxicity are evident in ovary, breast, liver, colon, pancreas, prostate, skin and blood cancer cell lines. Some active anticancer β-lactams in this series target specific genes. Ames assay, topoisomerase inhibition and cell cycles of the active β-lactams are investigated. The lead β-lactams arrest cell cycle at the G2/M checkpoint and inhibit protein synthesis.

Several significant chemical manipulations of the functionalized β-lactams are performed for the stereocontrolled asymmetric synthesis of structurally complex and novel multi-cyclic compounds.

Acknowledgements: B. K. Banik thanks USA NIH, USA NCI and Texas Private Foundations for financially supporting this research. Thanks are due to his 28 postdoctoral fellows/research scientists, 30 Ph. D. faculty researchers and hundreds of high school, B. S., M. S. and Ph. D. students who have participated in this research.

References:

1. For some books and patents on this topic, see: (a) Banik, B. K. “Heterocyclic Scaffolds I. Top. Heterocycl. Chem., Springer, 2010; (b) Banik, B. K. “β-Lactams: Synthesis and Biological Evaluation”, Top. Heterocycl. Chem., Springer, 2012; (c) Banik, B. K. “Beta Lactams: Novel Synthetic Pathways and Applications”, Springer Nature, 2017; (d) Das, A.; Banik, B. K. “Microwave in Chemistry Applications: Fundamental, Methods and Future Trends”, Elsevier, 2021; (e) Banik, B. K. “Green and Sustainable Approaches in Medicinal Chemistry-Methods-Volume 1 and Applications-Volume 2”, Elsevier, 2024; (f) Banik, B. K. and A. Das “Chemistry and Biology of Beta-Lactams”, CRC, 2024; (g) Becker, F. F.; Banik, B. K. “Polycyclic β-Lactam Derivatives for the Treatment of Cancer”, US Patent, Number US8946409, 2015; (h) Becker; F. F.; Banik, B. K. “Polycyclic β-Lactam Derivatives for the Treatment of Cancer”, World Patent, Number WO103456A2, 2012.

2. B. K. Banik et al. published 150 papers, US and World patents, reviews, books and book chapters on Beta-Lactams (out of his more than 750 published/accepted publications). For some of these, see the following journals: Angew. Chem. Int. Edn. Engl., Tetrahedron Symposium-in-Print, Tetrahedron Lett., Eur. J. Med. Chem., Synlett, Synthesis, RSC Advance, J. Med. Chem., Bioorganic & Med. Chem. Lett., Bioorg. Med. Chem., J. Org, Chem., Molecules, Frontier, Current Med. Chem., Aus. J. Chem., Rus. Chem. Bulletin, Heterocycles, J. Chem. Soc. Perkin Trans, ChemSelect, Future Med. Chem., J. Ind. Chem. Soc., and Catalysis Rev. For some of Banik’s publications, please see the books published by him in Springer Nature, Springer, Elsevier, CRC, Nova, ICS, De Gruyter, Springer and Wiley.

Arctic Psychtrophs Shows High Biotechnological Potential

Md Raihan Uddin[1*] and Sukhendu Mandal[2]

Department of Physiology & Biotechnology, Raja Narendra Lal Khan Womens College (Autonomous)[1]

Department of Microbiology, calcutta University[2]
E-mail: mdrahn@gmail.com

Abstract:

Polar microbiology remains as the most fascinating area of research which mainly focuses on exploration of psychrophilic organisms for having their cold-active enzymes of biotechnological potential. Total 27 psychrotrophs were isolated by prefarable LB media and characterized them for exploration of different bio-active molecules with special importance on enzyme and pigment which have potential application in biotechonological industry. All these isolates has been characterized further for their taxonomic identification and potentiality of enzyme and pigment production. According to physiochemical, chemotaxonomic and molecular systematic through 16S rRNA sequence analysis study predicted that there 3 new unique species of psychrotroph present among these 27 isolates. These three novel species, *Marinobacter sp., Oceaniosphera sp. and Salinibacterium sp.* were found from Arctic soil. From those unique isolate *Marinobacter sp* was subjected to small scale production and media optimization for lipase. The production and activity were found to be maximum in tributyrin, substrate supplemented media prefarable at 20℃-22℃, 2-3 days incubation, pH 9, 180 rpm agitation in addition 3% (w/v) Nacl concentration. Lipase Production, optimization and purification which is done through DEAE cellulose followed by 75% ammonium sulfate precipitation. Innvitrocally the lipolytic activity of the purified lipase has been done through zymogram analysis. The molecular weight found to be approx. 100 KD. Purified lipase MALDI-TOF-MS study showed the highest match with the sequence of prolipoprotein diacylglyceryl transferase.

One another important bioactive compound i.e pigment found from another unique strain Kocuria Sp. Extraction of the pigment was performed in methanol and acetone (2:1) and further purification was carried out through column chromatography. Establishment of the chemical characterization of the pigment was done by UV-Visible, fluorescence, IR, ^{1}H NMR,^{13}C NMR spectroscopy, mass spectrometry and CHN analysis. The molecular weight determined for the pigment AR-2 is near by 250 daltons and the molecular formula was $C_{15}H_{18}N_2O_2$. The pigment has protective roles against UV-mediate mutagenesis. In addition, it has been found that the pigment shows considerable antimicrobial effect and exerts antibiofilm formation capability by the pathogen in its sublethal concentrations. This newly characterized lipase and pigment from psychrotroph could be useful for its industrial application in near future.

Interconnection Between Somatic Embryo Development and Programmed Cell Death In Limonium Misty Blue

Tapas Kumar Bandyopadhyay
(Professor)
Department of Molecular Biology and Biotechnology, University of Kalyani, Nadia, West Bengal, India

Abstract:

Somatic embryogenesis (SE) represents a highly orchestrated developmental reprogramming process in which differentiated somatic cells acquire totipotency and initiate an embryogenic pathway culminating in the formation of bipolar embryos capable of regenerating complete plants. Unlike zygotic embryogenesis, SE is induced in vitro and constitutes a pivotal platform for clonal propagation, synthetic seed technology, genetic transformation, and functional genomics. Beyond cellular proliferation, SE involves precise spatial and temporal regulation of morphogenetic events, progressing through defined developmental stages—globular, heart, torpedo, and cotyledonary in dicotyledonous systems, and pro-embryo, scutellar, and coleoptilar stages in monocotyledonous systems—mirroring key aspects of zygotic embryo development.

The talk elucidates the intrinsic interconnection between somatic embryo development and programmed cell death (PCD), demonstrated for the first time in the dicotyledonous, non-model floricultural species Limonium 'Misty Blue'. PCD, a genetically regulated and orderly cellular dismantling process, plays an indispensable morphogenetic role during SE. In embryogenic callus, actively dividing peripheral cells contrast with centrally located cells undergoing selective PCD, thereby contributing to embryogenic lineage selection, nutrient redistribution, and spatial accommodation for embryo differentiation. Elimination of non-embryogenic cells enhances culture efficiency and supports embryonic progression through nutrient recycling. Furthermore, PCD-mediated tissue re-modelling establishes embryo boundaries, removes suspensor-like structures, defines polarity, and facilitates proper pattern formation, particularly during the globular-to-heart stage transition.

In vitro stress conditions, notably auxin-induced signalling, generate reactive oxygen species (ROS), which function as dual regulators of embryogenesis. Controlled ROS levels promote embryogenic competence, whereas excessive ROS accumulation activates PCD pathways. ROS-mediated events include mitochondrial dysfunction, DNA fragmentation, and activation

of caspase-like proteases. Although plants lack canonical animal caspases, they possess metacaspases and vacuolar processing enzymes (VPEs) that orchestrate cytoplasmic shrinkage, chromatin condensation, and vacuolar collapse during PCD.

The association between embryogenic development and PCD was substantiated through detailed anatomical and cytological analyses. Hallmarks of PCD during SE were confirmed by TUNEL-positive nuclei, DNA laddering patterns, and comet assay profiles, collectively establishing PCD as a central regulatory mechanism rather than a mere degenerative event in somatic embryo morphogenesis. This integrative perspective advances our understanding of developmental cell death as a constructive force in plant embryogenic competence and morphogenesis.

Evolution of modern technologies by sustainable reuse of waste polymers in construction and renewable energy production: Case Study

Monalisa Das[1], Mainak Debnath[2], Sreyasree Basu[2], Indrajit Bhattacharyya[2]

[1]Department of Computer Science and Engineering, Guru Nanak Institute of Technology, Kolkata, West Bengal, India

[2] Department of Applied Science & Humanities, Guru Nanak Institute of Technology, Kolkata, West Bengal, India
E-mail: monalisa9903935788@gmail.com

Abstract:

The most common polymer that we use in our daily life is 'plastic', an immense source of pollution that causes not only environmental hazards but also results in health deficits and extrinsic diseases to all living beings. Available research reports reveal that plastic wastes under high pressure and low temperature at the bottom of the seas and oceans for many years do not easily decompose due to its high tensile strength. Our study proposes how to reuse such plastic wastes in various fields of modern technology, constructions, defense sectors and space technology to promote sustainable development across the globe. This approach, in turn, leads to the reduction of global plastic pollution and hence can save the earth from such adverse global hazards. This paper mainly highlights the reuse of the plastic waste in various industrial sectors, particularly focusing on few specific case studies across different disciplines. Our first case study describes methodologies and techniques to reuse plastic for construction of roads. The second one relies on manufacturing casting materials from plastic wastes for the real estate sectors. Our third case study reveals how to reuse plastic materials for making hefty machines and lightweight HDPE based armours for defence and artillery purposes. The fourth case study describes how to reuse polymers to generate renewable electricity.

Pedagogical Innovations in Sustainability Education: Implications for Future Education Policy

Saidul Islam
(SACT)
Department of Education, Domkal Girls' College, Murshidabad, West Bengal, India
E-mail: saidulislam1991354@gmail.com

Abstract:

Sustainability education has become essential due to urgent global issues like climate change, environmental damage, social inequality, and economic instability. These challenges are connected and require a generation of learners who are not just knowledgeable but also skilled in critical thinking, ethical awareness, and problem-solving. However, traditional teaching methods that focus on delivering content and testing performance are not enough to prepare students. There is a growing need for new teaching methods in sustainability education. This paper looks at new teaching approaches in sustainability education and their impact on future education policy. It draws from current educational theories and global best practices. The study examines learner-centered teaching, hands-on experiences, technology-enhanced instruction, and values-based teaching methods. These innovative approaches foster sustainability skills like systems thinking, collaboration, civic responsibility, and ethical decision-making, which are important for tackling real-world sustainability problems. The paper argues that future education policies need to go beyond just adding sustainability topics to current curricula. They should support a complete change in teaching and learning processes. The study stresses the need for flexible, interdisciplinary curriculum frameworks, better teacher training and ongoing professional development, and assessment systems that prioritize critical reflection and practical use over memorization. It also points out the importance of supportive institutional governance and fair access to innovative teaching resources to ensure all students receive inclusive sustainability education. The paper concludes that incorporating innovative teaching methods into education policy is crucial for developing responsible citizens who are ready for the future and committed to sustainable development. By connecting teaching with policy, education systems can play a key role in creating a more just, resilient, and sustainable future.

Keywords: Sustainability Education, Pedagogical Innovation, Education Policy, Future Education, Transformative Learning

Biofuels: Towards Renewable energy and Sustainable Development

Sourajit Sarkar
(Assistant Professor)
Department of Chemistry, Vivekananda College, Kolkata-700063, West Bengal, India
Email: chem.ssarkar@gmail.com

Abstract:

Fuel is the most important sources of energy. The existence of our civilization is dependent on continuous supply of fuel. At present majority of the fuels used are fossil fuel (coal, petroleum, diesel) and natural gas. These fuels are extracted from the earth and made usable by refining. Being a critical component of the global economy, the demand for fuel is ever increasing. Fossil fuels pose numerous problems including climate change, air and water pollution, and resource depletion. Combustion of fossil fuels releases greenhouse gases (mainly CO_2). It causes global-warming and climate change. Air pollution from fossil fuel combustion leads to serious health issues, acid rain, and damage to ecosystems. The process of fuel extraction and transportation also cause pollution. To combat these issues research is ongoing over the past decades to develop greener alternatives of fossil fuels. Biofuels can be important source of renewable energy. Biofuel is produced from biomass such as plants or from agricultural, domestic or industrial bio waste. The use of biomass fuels provides considerable environmental benefits. Biomass absorbs CO_2 during increase and emits it at some point of combustion. Therefore, biomass helps the atmospheric CO_2 recycling and does not make contributions to the green-house effect. Different types of biofuels are: biodiesel, bio-alcohols, bio-hydrogen and bio-methane. Biofuels have several advantages over fossil fuels such as: renewable source material, lower environmental pollution, cost efficiency and economic benefit. Biofuels have several disadvantages as well. These are lower energy efficiency, requirement of huge amount of water, land usage issues etc. These issues need to be addressed so that an effective solution for the problems of environmental pollution and fuel crisis can be achieved.

Keywords: Environmental impact, Pollution, Global warming, Biomass energy, Circular economy efficiency.

Coliform Contamination in Groundwater of Chakdah Block, Nadia District, India

Sathi Das[1], Dr. Abhishek Basu[2*]
(Assistant Professor)

[1,2] Department of Molecular Biology and Biotechnology, Sripat Singh College, Murshidabad, West Bengal, India
Corresponding Author: Dr. Abhishek Basu
Affiliation: Department of Molecular Biology and Biotechnology,
Sripat Singh College, P.O. Jiaganj,
Murshidabad, West Bengal: 742123, India.
Email: abasu@sripatsinghcollege.edu.in

Abstract:

The study addresses depth dependent microbial (coliform) contamination of groundwater in

the shallow aquifers of Chakdah block of the Bengal Delta Plain, an issue of undeniable public health significance. Groundwater samples were collected from six Gram Panchayats in the Chakdah block, Nadia District, India to estimate the Total and Fecal Coliform. The risk associated with groundwater use pattern from six sites was analysed by the sanitary risk score and the Fecal Coliform score. Groundwater sources near surface water bodies (~2–3 m) have high total and Fecal coliform count. FC counts ranged from 10 to 100 CFU/100 mL. Coliform count varies seasonally in groundwater and shows higher count during the post-monsoon season. According to sanitary risk analysis, the monitored tube wells could be categorized as very high risk-25.0%, high risk-58.3%, intermediate risk-11.1%, and low risk-5%. The study advocates that microbial contamination of groundwater in the aforementioned region is a serious public health issue which needs attention (policy) at local and global platforms.

Keywords: Groundwater, Coliform, Sanitary risk, Contamination, Shallow Aquifers. elopment, Gender, Caste, Intersectionality, India, Educational Equity, Social Inclusion, Sustainability

Synthesis and Photophysical Investigation of a Biphenyl Triamine for Strong Acid Detection

Dr. Mrittika Mohar
(Assistant Professor)
Department of Chemistry, Sripat Singh College, Murshidabad, West Bengal, India Email:
Email: malda.mrittika@gmail.com

Abstract:

The careful design of biphenyl-based fluorescent molecules plays an important role in modern organic electronics and sensing materials. In this work, a reliable three-step method to synthesize methyl 2,2',4'-triamino-[1,1'-biphenyl]-4-carboxylate has been developed (compound 4). The synthesis begins with simple and easily available starting material [1,1'-biphenyl]-4-carboxylic acid Compound 1). The following synthetic procedure includes a high-yield esterification step, a highly selective trinitration controlled by electronic and steric effects, and finally, a chemoselective iron-mediated reduction to obtain the target triamine compound (Figure 1). Interestingly, compound 4 itself shows bright green fluorescence in organic solvents as well as water-organic mixed solvents. Photophysical studies reveal that compound 4 exhibits complete fluorescence quenching upon exposure to strong acidic media or strong acid vapour (Figure 1). This strong acid-induced quenching is attributed to protonation of the amino groups, which significantly alters the electronic distribution of the biphenyl framework and promotes non-radiative deactivation pathways. In contrast, under neutral and basic conditions, the molecule retains its bright fluorescence intensity, resulting in a clear and reversible fluorescence response across a wide pH range. Owing to its sharp and sensitive fluorescence modulation between acidic and basic environments, compound 4 can be effectively utilized as a strong acid–base sensor. The presence of multiple amino groups not only enhances proton sensitivity but also allows fine tuning of the sensing behavior through structural or environmental modifications. Overall, this work highlights compound 4 as a simple yet powerful molecular platform for acid–base sensing applications, with potential relevance in chemical analysis, environmental monitoring, and materials science.

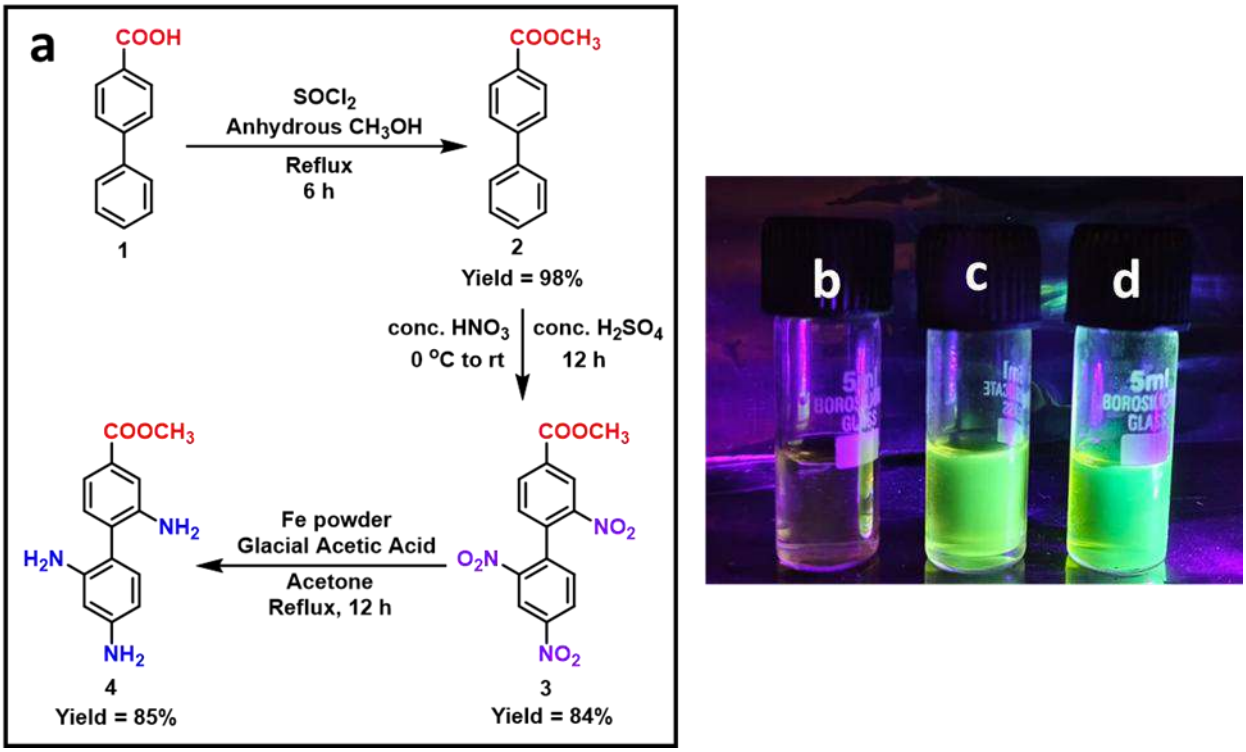


Figure 1: a) Synthesis of compound 4, b) Acetone-water (9:1) solution of 4 + HCl, c) Acetone-water (9:1) solution of 4 + NaOH, d) Acetone-water (9:1) solution of only compound 4.

Keywords: Biphenyl triamine; Fluorescence quenching; Protonation effect; Acid–base sensor; Photophysical properties

Gender role attitude and attitude towards marriage in relation to television serial addiction: A correlational study among male and female serial viewers of Kolkata

Souhardya Ray
(Guest Teacher)

Department of Botany, Murshidabad University, Murshidabad, West Bengal, India
Email: raysouhardya.lifescience@gmail.com

Abstract:

The pursuit of Sustainable Development Goals (SDGs) has intensified interest in circular bio-economy models that integrate biological processes with economic sustainability. Managed green landscapes, including academic campuses, public institutions, and organized green spaces, generate substantial quantities of biodegradable waste such as leaf litter, kitchen residues, pruning biomass, and paper waste. Conventional linear waste management practices treat these materials as disposal burdens, resulting in environmental stress and recurring economic costs. The present study investigates circular bio-economy models that convert organic waste into productive botanical resources, thereby transforming managed green landscapes into self-sustaining systems. Emphasis is placed on biologically mediated waste-valorization pathways, including composting, vermicomposting, bio-mulching, and plant–microbe interactions. The effectiveness of circular treatments was evaluated through comparative analysis of soil physicochemical properties, germination assays using Cicer arietinum L. and Lathyrus sativus L., and cytological screening of root-tip cells in Lathyrus sativus to assess mitotic index and abnormality scoring. The results demonstrate improved soil quality, enhanced germination performance, and genetic stability under circular bio-economy-treated soils compared to chemically fertilized and untreated controls. From a botanical perspective, organic waste recycling enhances nutrient availability, microbial activity, and overall plant health while reducing dependence on synthetic fertilizers. Economically, circular utilization of organic waste lowers disposal and input costs and generates long-term value through ecosystem services and reduced maintenance requirements. The study further highlights the relevance of green accounting and cost–benefit considerations in evaluating the feasibility and scalability of circular bio-economy-based landscape models. By effectively linking botanical processes with economic value generation, such models offer replicable, interdisciplinary solutions for sustainable green space management. Integrating scientific research with practical implementation, these approaches contribute to zero-waste objectives, sustainability education, and the broader goals of environmental stewardship and sustainable development.

Keywords: SDGs, circular bio-economy, mitotic index, abnormality scoring, sustainable green space

Dynamics of Neutral Particles Around a Spherically Symmetric Black Hole in F(R) Gravity

Prosanta Mandal
(Assistant Professor)
Department of Mathematics, Sripat Singh College, Murshidabad, West Bengal, India
Email: prosantamandal84@gmail.com

Abstract:

Different types of observations such as supernova type Ia and cosmic microwave background radiation indicate that our universe is expanding at accelerated rate. Accelerating expansion of the universe is one of the most important puzzles of contemporary physics. To explain this, result a non zero vacuum energy is considered which is called cosmological constant. But it faces some major problems like coincidence problem and finetuning problem. This problem can be solved partially by considering the varying dark energy model. This type of effective time varying equation of state can be provided by the modified gravity. f(R) gravity is one of such modified gravity. I have studied dynamics of neutral particle around a black hole which is the solution of the field equation in f(R) gravity where the space time metric was taken as spherically symmetric. Collision of a neutral particle moving around the black hole with another neutral particle has been discussed. By numerical solution of the equations of motion it has been shown that after collision if the particle gets sufficient energy, then it can escape to infinity.

Keywords: Euler-Lagrange equation; cyclic co-ordinate; escape velocity and effective potential.

Next Generation Renewable Energy & Storage Technologies

Amitava Kar
Department of Environmental Science, Sripat Singh College, Murshidabad, West Bengal, India
Email: akarbhp@gmail.com

Abstract:

Human civilization is a continuous process from the primitive man to modern era where technology, science, engineering etc. give immense impact on our daily lives. From pre industrial era to modern period the need of energy increasing very fast. Now at this era & future generation's need the non renewable resources are not our first priority. The renewable ecofriendly energy resources are eligible alternative of non renewable counterpart. But these energy sources should be implemented with proper & sustainable way. Solar energy, hydro energy, wind energy etc. are some popular & well accepted renewable energy resources. International solar alliance (ISA) was established in 2015 to give solar energy in household purposes which reduce the expenses of electric bill which is basically depend on energy supply from coal based thermal power plant. Efficient solar panel & solar incoming radiation (free) are the main components of solar energy production. Wind energy also uses wind speed & velocity to electrical energy require proper air pressure & air circulation area basically the coastal region where sea & land surface create wind with working velocity. Hydel electricity is generated using the speed of water from certain height of dam & this energy is very popular in India after thermal power plant. The dams on altitude are to be properly built to generate this energy without the disturbance in environment. Only the water, air, solar luminescence are the raw materials for generation of this energy. Modern science & engineering encourages & works on ocean thermal energy conversion & tidal energy which will be the only source of energy in coming future. Many countries which have large coastal area like Japan, Korea, some European countries utilize this energy as they have control over human population & energy need.

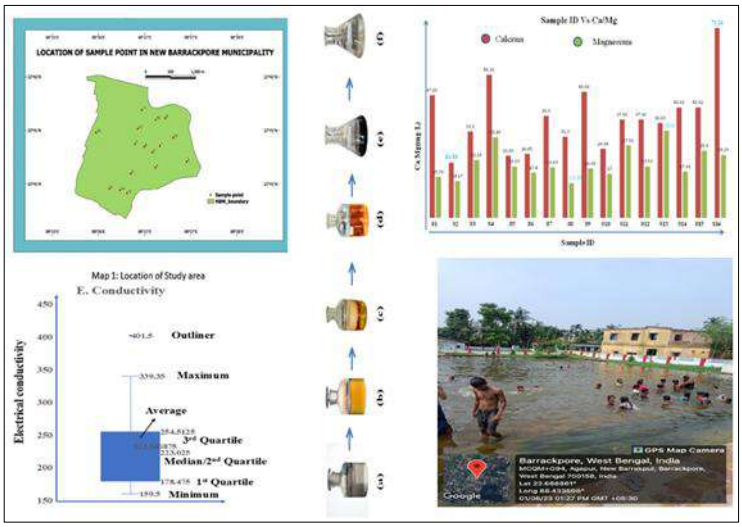
Integrated Physico-Chemical and Statistical Analysis of Surface Water Quality: A Case Study of New Barrackpore Municipality Area of West Bengal

Debashis Mallick* [1], Anup Dolai[2], Mrinmoy Paik[2], Mrinal Kanti Roy[3]

[1] Dept. of Chemistry, Mrinalini Datta Mahavidyapith, Kolkata- 700 051, W.B., India
[2] P.G. student, Dept. of Chemistry, Acharya Prafulla Chandra College, New Barrackpore, Kolkata-700051, W.B., India
[3] Dept. of Geography, Mrinalini Datta Mahavidyapith, Kolkata -700 051, W.B., India
* Corresponding author. E-mail address: dmchemmdm51@gmail.com (D. Mallick)

Abstract:

This work represents the experimental and statistical study of surface water (Pond water) on the basis of some common selected physico-chemical water quality parameters like temperature, conductivity, total dissolved solids, hydrogen ion concentration in the form of pH, dissolved oxygen, calcium ion concentration, magnesium ion con centration and water hardness in the New-Barracpore municipality area under the district of North 24 Paraganas of west Bengal. Samples were collected from sixteen different locations using the altimeter map camera and GPS (global positioning system) network, so the latitude, longitude, and altitude of the reference points as well as the exact time of collection were noted. Results were linked with standard permissible value following the guidelines of the World Health Organisation (WHO) and the Bureau of Indian Standards (BIS). The technique, Weighted Arithmetic Water Quality Index (WQI) method has been used to assess the overall quality of water based on experimented results. Box and whisker plot has been used for the quick overview of all the experimented results of water quality indicators. The interrelationship among the investigated parameters also has been established by calculation corelation coefficients by using Person's corelation matrix method which revealed that electrical conductivity shows a very strong positive correlation with calcium, magnesium, hardness and chloride. Results of WQI calculations indicates that the water quality of most of the ponds are poor or very poor quality i.e. not suitable for even domestic or industrial purposes, need proper treatment before use though quality of water of some selected ponds are fair in quality which may be used for irrigation or industrial purpose without any treatment.



Keywords: New Barrackpore, Surface water, WHO & BIS, WQI, Person's corelation.

Role of Sustainable Environment System in an Ecological and Economic Assessment of Urban Areas

Dr. Laxmi Biban*, Dr. Roop Raj

Department of Botany, S.U.S. Government College Matak Majri, Indri Karnal
Department of Botany, Economics, HNBG Central University, Uttarakhand, India
Email: rooprajgahlot@gmail.com

* Corresponding author: Dr. Laxmi Biban
Affiliation: S.U.S. Government College Matak Majri, Indri Karnal
Email: laxmibibanbotany@gmail.com

Abstract:

Urban development is an objective and irreversible consequence of scientific and technological progress, the result of which is manifested in a change in the urban environment. In this paper, **"role of sustainable environment system in an ecological and economic assessment of urban areas"** in consideration of ecosystem services were built for evaluating urban systems' sustainability performance The advancement of monetary movement over the long run, from the perspective of the economy, is entirely beneficial, yet the development underway volumes are described by a significant level of an anthropogenic effect on the climate. In such a situation, it is quite difficult to prioritize. Analysis of the ecological-economic state of urban areas, their organization and use, reveals that in the modern conditions of the city's existence, the rational use of urban landscapes is acquiring new dimensions. In this regard, to ensure sustainable development of urban areas, it is necessary to consider and assess both the economy concerning the natural environment and the economy. This work provides valuable insight into urban systems' social, environmental, and economic performances, helping decision makers with urban development, especially when the decisions need to be made regarding sustainability. This work provides valuable insight into urban systems' social, environmental, and economic performances, helping decision makers with urban development, especially when the decisions need to be made regarding sustainability.

Keywords: Sustainability, Emerge, Ecosystem services, urban ecological, economic systems

Bacterial Biofertilizer: A tool for smart agriculture

Bikram Ghosh, Tritha Chatterjee, Palash SK, Dr. Debjani Mandal, Dr. Abhishek Basu*

Department of Molecular Biology and Biotechnology, Sripat Singh College, Murshidabad, West Bengal, India.

*Corresponding Author: Dr. Abhishek Basu
Affiliation: Department of Molecular Biology and Biotechnology, Sripat Singh College, Jiaganj, Murshidabad, West Bengal, India.
E-mail: abasu@sripatsinghcollege.edu.in

Abstract

Soil microorganisms are integral to nutrient cycling, soil fertility enhancement, and sustainable agricultural productivity through their involvement in key biogeochemical processes. The present study aimed to isolate, enumerate, and characterize plant growth–promoting (PGP) bacteria, with emphasis on free-living nitrogen-fixing bacteria (NFB) and phosphate-solubilizing bacteria (PSB), from distinct agro-ecological regions of West Bengal, India. Soil samples were collected from Ahaldara, Kurseong (27 °C), a forest-dominated slightly acidic region (pH 6.2), and Jiaganj (28 °C), an agriculturally active neutral to slightly alkaline zone (pH 7.4). An additional PGP bacterium was characterized from Bhagobangola I Block. Serial dilution and spread plate techniques were employed using selective media including Jensen's nitrogen-free medium, Pikovskaya's medium, and Aleksandrow's medium. Ahaldara soil exhibited significant growth on Jensen's medium, indicating the presence of free-living diazotrophs with a population density of 4.3×10^5 CFU mg^{-1} soil. Jiaganj soil demonstrated prominent halo zone formation on Pikovskaya's medium, confirming phosphate solubilization ability, with a population density of 3.6×10^5 CFU mg^{-1} soil. The PSB likely mobilize insoluble phosphates through organic acid production and proton extrusion mechanisms. Furthermore, Microbacterium paraoxydans, isolated from soil and groundwater samples of Bhagobangola I Block, exhibited multiple plant growth–promoting (PGP) traits, including nitrogen fixation, phosphate solubilization, indole-3-acetic acid production, and siderophore synthesis. These multifunctional attributes enhance nutrient availability, root development, and plant stress tolerance. The findings underscore the ecological diversity and functional significance of beneficial soil microbiota across varying agro-climatic conditions and highlight their potential application as biofertilizer agent to promote sustainable agriculture and reduce dependency on chemical fertilizers.

Keywords: Plant Growth Promoting Bacterium, Atmospheric Nitrogen fixation, Phosphate Solubilisation, IAA and siderophore production, Biofertilizer, Microbacterium paraoxydans.

Application of Mathematics for Sustainability

Ashok Raj Mahali
(Assistant Professor)
Department of Mathematics, Sripat Singh College, Murshidabad, West Bengal, India
Email: ashok.rajmahali@gmail.com

Abstract:

Sustainable development is important in meeting human needs conserving natural resources, achieving harmony between natural resources and people as well as it is also important preserving natural resources for future. Mathematics has a significant role to play in acquiring the problem-solving skills necessary for meaningful educating, environmental, economic and social responsibility for sustainable development. Mathematical modeling plays and effective role in achieving understanding, prediction and control of development process in the field of sustainable development. It is widely used in the nature science, engineering discipline and social science. Differential equations, numerical simulations and Probability are used to predict climate change and analyze ecosystem health. Mathematical algorithms are used to efficiently manage resources such as water and energy, which encourages sustainable consumption. Big data and statistics are used to track the process towards the sustainable development goals. Assessing sustainability in quantitative terms requires the applications of mathematical models taking into account a large number of indicators, processes and their interrelationships and constructing both current and future values for various indicators.

Keywords: sustainable development, problem-solving skills, Mathematical modeling, Probability Differential equations, numerical simulations.

Impact of Vaccination on Transmission Dynamics of COVID-19

Sudhanshu Kumar Biswas
(Assistant Professor)
Department of Mathematics, Sripat Singh College, Murshidabad, West Bengal, India
Email: sudhanshukumarbiswas207@gmail.com

Abstract:

In this work I have developed a mathematical model on COVID-19 incorporating three doses of corona vaccine and studied the impact of these vaccines on the disease dynamics. In our study, we have sought the conditions for eradication of the virus from the environment. To understand the consistency of the model, we have studied first its positivity and boundedness. Then we have carried out it's steady state analysis. The stability of the COVID-free equilibrium (CFE) and COVID-endemic equilibrium (CEE) points have analyzed with the help of the reproduction number (R0), which is derived by the next- generation matrix approach. Further, this model has been validated by estimated model parameters and real data reported from India. Most effective model parameters are found by sensitivity analysis. Our findings show that first and second dose of covid vaccine are not sufficient for eradication of the disease from the population, but the third dose (or booster dose) is able to control the disease if no comorbidity is considered.

Applications of AI in Agriculture for a Sustainable Future: A Review

Arpita Prasad[*1], Soumi Patra[2], Indrajit Bhattacharyya[3], Shirsendu Dutta[4]

[1, 4] Department of Computer Applications, Guru Nanak Institute of Technology, India
[2, 3] Department of Applied Science and Humanities, Guru Nanak Institute of Technology,

*Corresponding Author: Arpita Prasad
Affiliation: Department of Computer Applications, Guru Nanak Institute of Technology, India
Email: prasadarpita2005@gmail.com

Abstract:

AI is transforming agriculture in terms of efficiency, productivity, and sustainability. With global food demand on the rise, AI-based technologies can help with unpredictable weather, pest infestations, and so on. This study explores the application of artificial intelligence in agriculture for a sustainable future. Precision agriculture includes automated irrigation systems, pest and disease detection, and production prediction. Farmers are increasingly making data-driven decisions to use machine learning models and computer vision approaches that help with waste minimisation.

Artificial intelligence helps drones and robotics. Climate forecasting and analytics also help to prevent climate-related dangers to agriculture. Though AI has many advantages, there are some drawbacks, including high implementation costs, data privacy concerns, and limited technological access. This article discusses the benefits of AI in agriculture, as well as its limitations, and specifies the potential for AI-based farming improvements that might be made available to everyone.

Keywords: Smart Irrigation Systems, Agrobot, AI-assisted climate adaptation strategies, Advanced Robotics.

Science and Nationalism in Colonial India: Scientific Institutions and Nation-Building

Dr. Sharmila Datta Banik
(Assistant Professor)
Department of History, Sripat Singh College, Murshidabad, West Bengal, India
Email: sharmilahist@gmail.com @gmail.com

Abstract:

The relationship between science and nationalism in colonial India played a crucial role in shaping intellectual resistance, modern education, and visions of national progress. During the late nineteenth and early twentieth centuries, Indian scientists, educators, and reformers increasingly viewed scientific knowledge not merely as a colonial import but as a powerful instrument for self- strengthening and nation-building. This paper examines the emergence of scientific institutions such as the Indian Association for the Cultivation of Science, the Indian Institute of Science, and nationalist educational initiatives that promoted indigenous scientific research and technical education.

By analyzing the contributions of key figures including Jagadish Chandra Bose, Prafulla Chandra Ray, and Meghnad Saha, the study highlights how science became intertwined with the broader nationalist discourse, challenging colonial narratives of intellectual inferiority of Indians. The paper also explores how scientific societies, journals, and educational reforms fostered a sense of collective identity and intellectual autonomy among Indians.

Through historical and textual analysis, this research highlights the long-term influence of colonial-era scientific movements on Indian's present scientific culture and pedagogical approaches.

Keywords: Science education, nationalism, colonial India, scientific institutions, intellectual history

Cadmium (II)-Iodo Complexes of Long Chain 1-Alkyl-2-(Arylazo) Imidazoles, Photochromism, Liquid Crystal Properties and the DFT Correlative Studies

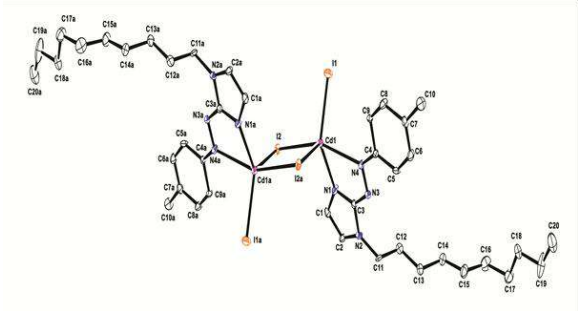
Dr. Chandana Sen
(Assistant Professor)

Department of Chemistry, Behala College, Behala, Kolkata-60,West Bengal, India
E-mail ID: chandanasen2016@gmail.com

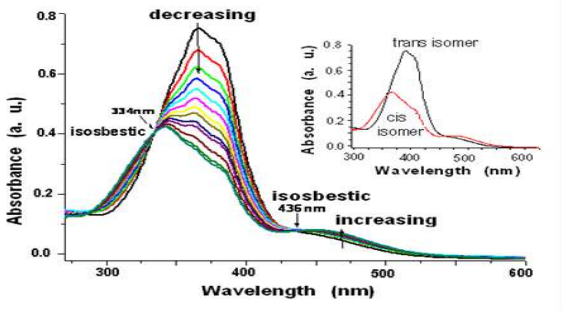
Abstract:

1-Alkyl-2-(arylazo)imidazole (Raai-C_nH_{2n+1}, n = 10 (**1**), 12 (**2**), 14 (**3**), 16 (**4**), 18 (**5**), 20 (**6**), 22 (**7**)) exhibits UV light assisted photoisomerisation (E(*trans*)-to-Z(*cis*)) both in free and coordination state in the complexes, $[Cd(Raai\text{-}C_nH_{2n+1})(\mu\text{-}I)I]_2$ (**8-14**) and $[Cd(Raai\text{-}C_nH_{2n+1})_2I_2]$ (**15-21**). The complexes are characterized by spectroscopic data (UV-Vis, FTIR, ^{1}H-NMR, Mass). The structures of two representative complexes, $[Cd(Meaai\text{-}C_{10}H_{21})(\mu\text{-}I)I]_2$ (**8b**) and $[Cd(Haai\text{-}C_{10}H_{21})_2I_2]$ (**15a**) have been supported by single crystal X-ray diffraction study. The Z-to-E (*cis*-to-*trans*), isomerisation is very slow with visible light irradiation and has been carried out under thermal treatment. The quantum yields ($\phi_{E\rightarrow Z}$) of free ligands are higher than that of the respective complexes. The activation energy (E_a) is also lower in the complexes than the free ligand data. The presence of long chain alkyl group (-C_nH_{2n+1}) in imidazolyl motif brings flexibility in the structure and show liquid crystal properties under Polarizing Optical Microscope. Differential Scanning Calorimetry (DSC) has been used to calculate energy of phase transition states. The spectral and Polarizing properties have been explained using DFT computation studies of optimized geometries of $[Cd(Meaai\text{-}C_{10}H_{21})(\mu\text{-}I)I]_2$ and $[Cd(Haai\text{-}C_{10}H_{21})_2I_2]$.

Keywords: Cadmium(II)-arylazoimidazoles, X-ray structures, photochromism, liquid crystal properties, DFT Computation.



ORTEP of $[Cd(Meaai\text{-}C_{10}H_{21})(\mu\text{-}I)I]_2$ (8b) with 30% ellipsoid probability. Hydrogen atoms are omitted for clarity



Spectral changes of $[Cd(Haai\text{-}C_{10}H_{21})_2I_2]$ in MeOH upon repeated irradiation at 366 nm at 5 min interval at 25^{0}C. Inset figure shows spectra of E (*trans*) and Z (*cis*) isomer of the complex

[21]

SCIENCE FOR HEALTH AND WELL BEING

(Biotechnology Based Strategies for Disease Detection and Wellness Promotion)

Agniva Kushari, Soma Kundu, Arpita Mandal, Arobindo Konai
Dr Abhishek Basu* , Dr Debjani Mandal
Department of Molecular Biology and Biotechnology, Sripat Singh College, Murshidabad, West Bengal, India.

*Corresponding Author: Dr. Abhishek Basu
Affiliation: Department of Molecular Biology and Biotechnology, Sripat Singh College, Jiaganj, Murshidabad, West Bengal, India.
E-mail: abasu@sripatsinghcollege.edu.in

Abstract:

Health and well-being are governed by complex interactions among genetic, metabolic, microbial, and environmental factors. From a biotechnology perspective, health is maintained through molecular homeostasis involving regulated gene expression, balanced metabolic pathways, efficient immune surveillance, and stable neuroendocrine signaling. Modern biotechnology contributes to health promotion by enabling early diagnosis (PCR, ELISA, biosensors), therapeutic interventions (recombinant proteins, gene therapy, vaccines), and personalized medicine based on genomic and proteomic profiling. Advances in microbiome research, nutrigenomics, and systems biology further demonstrate that well-being is a result of coordinated cellular processes rather than isolated physiological events. Thus, biotechnology integrates molecular biology, biochemistry, and immunology to understand, monitor, and enhance human health at the cellular and genetic levels.

Keywords: Biotechnology, Molecular homeostasis, Gene expression, Immune system, Personalized medicine, Microbiome, Human health.

Development of a Reversible Fluorescent Organic Indicator for Determination of Total Acid Number (TAN) in Industrial Lubricating Oils

Dr. Tanmay Das
(Assistant Professor)
Department of Chemistry, Abhedananda Mahavidyalaya, Sainthia, West Bengal, India
Email: tanmay.greenview@gmail.com

Abstract:
Accurate monitoring of acidity in industrial lubricants is essential for the predictive maintenance of machinery used in power plants and the automotive sector. The Total Acid Number (TAN) is commonly determined using colorimetric titration methods. However, these methods often fail when analyzing dark, degraded, or turbid oil samples, where the color change at the endpoint is difficult to observe clearly. To overcome this limitation, a fluorescent organic indicator was prepared from the reaction of N,N′-dicyclohexylcarbodiimide (DCC) and picric acid. The resulting compound (1) displays a distinct orange-red color, with dual absorption peaks at 405 nm and 530 nm, and exhibits a bright yellow fluorescence emission at 565 nm (λ_{ex} = 405 nm). Upon interaction with acidic species, the molecule undergoes reversible protonation, leading to a complete “switch-off” of fluorescence and conversion to a colorless, non-emissive state. This sharp fluorescence change allows highly sensitive detection of acidic content. The indicator was successfully applied to determine the TAN of various lubricating oils used in thermal power plants, including MOT (main oil tank) oil, BFP (boiler feed pump) oil, and different transformer oils. Compared to the conventional bromocresol green colorimetric method, the fluorescent approach provides a much sharper and more reliable endpoint, especially for dark and highly degraded oil samples where visual color detection is extremely challenging (Figure 1). Overall, this fluorescence-based method offers a robust and practical alternative for accurate quality control and monitoring of oil degradation in industrial applications.

Keywords: Fluorescent indicator, Total Acid Number (TAN), Lubricating oil analysis, Fluorescence quenching, Industrial oil degradation monitoring

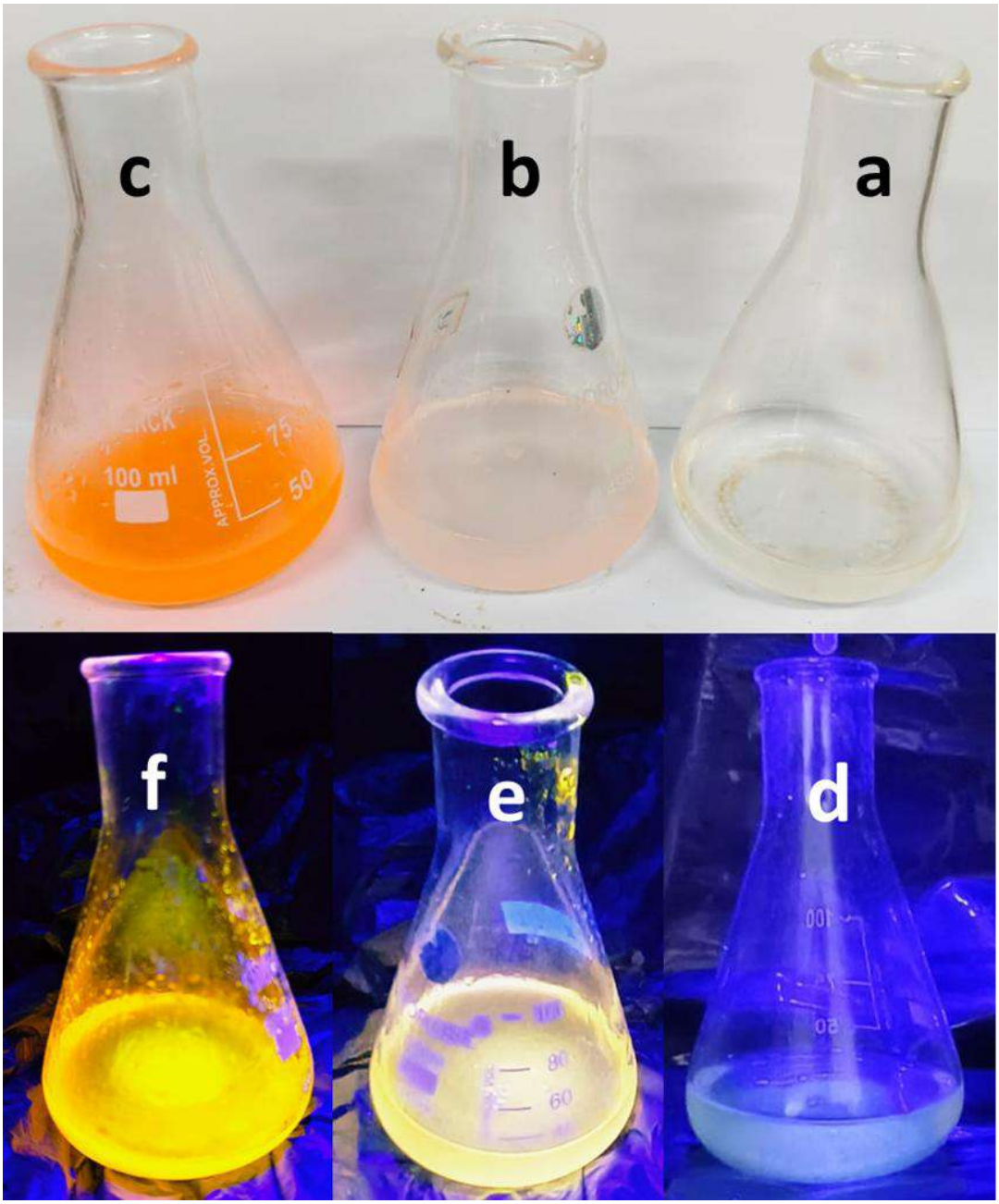


Figure 1. a) A dilute solution of used MOT oil in isopropanol-water (9:1) containing 4 drops of 0.1% solution of compound **1**, b) solution 'a' at the neutralization point while titrating with standard KOH solution, c) solution 'a' after reaching visually detected neutralization point while titrating with standard KOH solution, d) solution 'a' under blue LED, e) solution 'b' under blue LED, and f) solution 'c' under blue LED.

Green Energy for Sustainable Development

Sanjay Nath
(Associate Professor)
Department of Chemistry, Murshidabad University, Murshidabad, West Bengal, India
Email: snche@msduniv.ac.in

Abstract:
Sustainable development is the "development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs". Modern lifestyle, industrialization etc. consume lots of energy of which majority comes from nonrenewable energy resources include coal, natural gas, oil. Once these resources are used up, they cannot be replaced - sustainable issue, which is a major problem for humanity as we are currently dependent on them to supply most of our energy needs. Further these create great environmental issues – causes air pollution, produce greenhouse gases which is responsible for global warming, residual products are non-biodegradable.

Green energy is the solution to these problems. Green energy is any energy type that is generated from natural resources, such as sunlight, wind or water. It often comes from renewable energy sources. The key with these energy resources are that they don't harm the environment through factors such as releasing greenhouse gases into the atmosphere and do not causes air pollution. The most common forms of green energy are Solar Energy, Wind Energy, Geothermal Energy, Tidal Energy, Biomass, Hydropower, Biofuels and one of the most important in the present day is Hydrogen Fuel. Hydrogen fuel is a versatile, high-energy-density, clean energy carrier that produces only water when consumed in fuel cells or burned, making it a key technology for decarbonizing transportation, industry, and power generation. Hence for energy consideration we must go from nonrenewable energy to renewable green energy, so that we make our environment green to achieve a sustainable society by pollution prevention for our future generation.

Keywords: Wind Power, Geothermal, Hydropower, Tidal Energy, Solar Power, Hydrogen fuel

Eco-Schools and NEP 2020: A Pathway to Environmental Stewardship

Abdullahilbaki
(Research Scholer)

Department of Education, Eklavya University, Damoh, M.P, India
E-mail:abdullahilbaki101@gmail com

Abstract:

Environmental degradation, climate change, biodiversity loss, and resource depletion have intensified the need for sustainable education systems worldwide. In India, the National Education Policy 2020 (NEP 2020) envisions a transformative framework that integrates environmental awareness, sustainability, and experiential learning acros all levels of education. Parallelly, the Eco-Schools programme—coordinated globally by the Foundation for Environmental Education—promotes environmental stewardship through participatory, action-oriented learning in schools.

This paper examines the alignment between Eco-Schools and NEP 2020, exploring how their integration can foster environmental responsibility, sustainable lifestyles, and global citizenship among learners. It analyzes key principles, implementation strategies, challenges, and future directions for embedding environmental stewardship in Indian education. The growing climate crisis and ecological degradation demand transformative changes in education systems. The National Education Policy 2020 envisions holistic, experiential, and multidisciplinary learning, creating significant opportunities to embed environmental consciousness within mainstream education. This seminar explores how the Eco-Schools framework aligns with the vision of NEP 2020 to cultivate environmental stewardship among students. Eco-Schools promote sustainable practices through student-led initiatives in areas such as waste management, biodiversity conservation, water preservation, and energy efficiency.

By integrating environmental education across curricular and co-curricular domains, NEP 2020 encourages critical thinking, problem-solving, and value-based learning—core principles that resonate with the Eco-Schools model. The policy's emphasis on experiential learning, local context, and community engagement further strengthens the potential for schools to become centers of sustainable development.

This paper argues that the convergence of Eco-Schools initiatives and NEP 2020 can nurture environmentally responsible citizens equipped to address contemporary ecological challenges. It highlights implementation strategies, institutional responsibilities, and long-term benefits for sustainable development in India. Ultimately, Eco-Schools under NEP 2020 represent a practical pathway to fostering ecological literacy and responsible citizenship among future generations.

Keywords: Eco-Schools, NEP 2020, Environmental Education, Sustainability, Experiential Learning, Climate Action

Impact of Behaviouralism in 'Science of Politics' : A Study of Political Behaviour through Empirical and Scientific Methods

Subhojit Kundu
(Assistant Professor)
Department of Political Science, Sagardighi Kamada Kinkar Smriti Mahavidyalaya, Murshidabad, West Bengal, India
Email: kndsubho@gmail.com

Abstract:
Research in 'Science of Politics' or Political Science or Political Behavioralism influenced by Empiricism, which is a except of sensible and direct observation and can be proven through experiments. As per analytical view of empiricism, political phenomena are to be data-rich and need to be verified in terms of real experience. In this point of view, Behaviouralism is a notion, derived from empiricism. Behaviouralism believed that age old traditional approaches totally neglected the political phenomena or real incidence relating to political behaviour of human being and the study of political institutions such as the state and government was not adequate and that's why additional methods could be developed which may yield better results. Hence, Behaviouralists advocated a careful analysis and research of the political phenomena like election, voting behaviour, public policy etc. which could be done through the behavioural, empirical or scientific method. In this paper, trying to focus how to make 'Science of Politics' or Political Science a more up-to-date and realistic study in the higher educational institutions by using scientific – empirical methods.

Keywords: Behaviouralism, Empirical, Political Phenomena, Experiments.

Centenary of Quantum Mechanics

Basir Ahamed Khan

Department of Physics, Murshidabad University, Berhampore, West Bengal, India
Email: bakhan.mu@gmail.com

Abstract

The year 2025 marks the centenary of Quantum Mechanics, one of the most profound and transformative scientific revolutions in human history. Emerging in the early twentieth century through the pioneering works of Max Planck, Werner Heisenberg, Erwin Schrödinger, Niels Bohr, and others, Quantum Mechanics fundamentally changed our understanding of nature at microscopic scales. It introduced revolutionary concepts such as wave–particle duality, quantization of energy, uncertainty principle, and probabilistic interpretation of physical phenomena, challenging the deterministic framework of classical physics.

Over the past hundred years, Quantum Mechanics has not only provided deep insights into the structure of atoms, molecules, and solids, but has also led to remarkable technological advancements including semiconductors, lasers, magnetic resonance imaging, and quantum computing. Today, the second quantum revolution is underway, focusing on quantum technologies such as quantum communication, quantum sensing, and quantum information processing, which promise to reshape science and technology in the twenty-first century.

The centenary celebration of Quantum Mechanics offers an opportunity to reflect on its historical development, recognize its scientific and technological impacts, and inspire future generations of researchers and students. It highlights the continued relevance of quantum theory in addressing fundamental questions and driving innovation, ensuring its central role in shaping the future of physics and modern society.

Keywords: quantum mechanics, wave-particle duality, uncertainty principle, quantum computing.

Preparing Future Teachers: Personality Development for Sustainable Education

Md Sariful Hoque, Research Scholar, University of Lucknow
Dr. Mohammad Imran, Assistant Professor, A.N.D Teachers' Trainning (P.G) College, Sitapur
E-Mail: mdsarifulhoque10@gmail.com

Abstract:

The growing urgency of global challenges such as climate change, social inequality, and environmental degradation demands educators who are not only knowledgeable but also personally committed to sustainable values. Preparing future teachers for sustainable education requires intentional attention to personality development alongside pedagogical competence. This paper examines how key personality traits—such as empathy, openness to experience, ethical integrity, resilience, and reflective disposition—contribute to effective sustainability teaching. Drawing on educational psychology and teacher education research, it argues that personality significantly influences classroom climate, student engagement, moral modeling, and the ability to facilitate critical dialogue on complex global issues. Teachers who demonstrate strong interpersonal skills and ethical awareness are better equipped to promote systems thinking, collaborative learning, and responsible citizenship. Additionally, reflective and growth-oriented dispositions support continuous professional development and adaptive teaching practices in dynamic social and environmental contexts. The paper proposes a framework for integrating personality development into teacher education programs through reflective practice, mentorship, experiential learning, community engagement, and values-based training. It emphasizes that sustainable education is not solely content-driven but fundamentally relational and value-oriented. By cultivating personal qualities aligned with sustainability principles, teacher preparation programs can nurture educators who act as transformative agents of change and inspire long-term environmental responsibility and social well-being.

Keywords: Sustainable Education, Teacher Personality, Teacher Preparation, Professional Development, Transformative Learning

Tunable Photoluminescence of Ion-beam-synthesized Au-Si Composite in SiO2

Dr. Debi Prasad Datta
Department of Physics, Sripat Singh College, Murshidabad, West Bengal, India
Email: debipr@gmail.com

Abstract:

Emission properties of Si nanocrystals are under intense investigation in relation to application in Si-based photonic and optoelectronic devices, because the nanocrystals exhibit photoluminescence in visible range at room temperature due to radiative recombination of quantum-confined excitons. However, the indirect band gap of Si results in a low radiative decay. A route towards enhancement of rediative recombination is electromagnetic coupling of Si nanocrystal emitters with plasmonic field of metal nanoparticles [1]. Regarding the synthesis of Si-metal nanocomposite systems necessary for enhancement of radiative emission of Si, energetic ion irradiation is a very efficient process. In this work, we carry out 500 keV Xe^{2+} ion irradiation on a 5 nm Si layer and Au/Si layer deposited on thermally grown SiO_2, to fluences in the range of 5×10^{14} - 1×10^{16} ions cm^{-2}. A clear PL peak, at 354 nm, appears in the spectra of Au/Si double layered samples after ion irradiation to fluence of 2×10^{15} ions cm^{-2}, where a fluence dependent red shift of the peak is discernible. On the other hand, no peak is visible in the spectra of samples comprising of only Si layer on SiO_2 which clearly shows the role of Au in the observed PL emission. We discuss our experimental results in terms of electromagnetic coupling in Au-Si nanocomposite fabricated in SiO_2 by the irradiation process. This mechanism is further substantiated by the results of uv-visible absorption, grazing incident x-ray diffraction, and Raman spectroscopic studies carried out on the samples.

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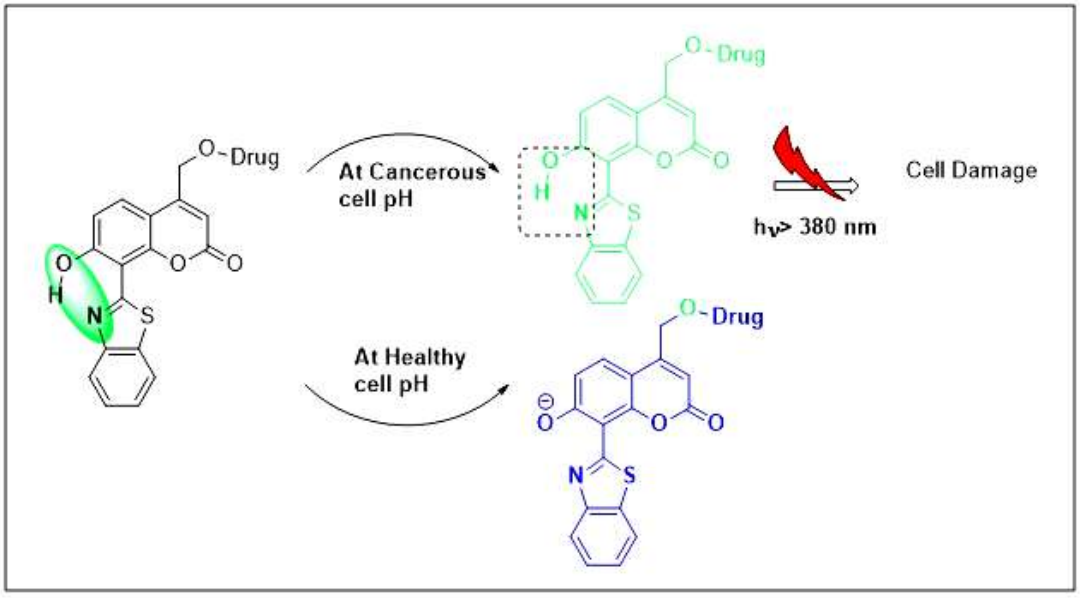
Benzothiazole Based Coumarin: Promising and Versatile Component for Cancer Therapy

Dr. Shrabani Barman
(Assistant Professor)
Dept of Chemistry, Murshidabad University, West Bengal, India.

Abstract:

7-hydroxycoumarin, a promising candidate in the field of controlled delivery of drug. Consolidation of fluorescence behaviour of coumarin and ESIPT, immensely enhanced the fluorescence intensity, sensitivity towards polarity of the solvent, pH of the medium and cell permeability of benzothiazole based coumarin compound. Benzothiazole appendage Hydroxycoumarin will be a promising and potential agent for cancer therapy.



Scheme: Working protocol of Benzothiazole based Hydroxycoumarin compound.

Keywords: Coumarin, ESIPT, Cancer Therapy, Drug Delivery, pH Sensitivity.

A Comprehensive Bibliometric Analysis of Journal of Chemical Sciences from 2021 to 2025

Dibakar Das*

Librarian, Sripat Singh College & Research Scholar, Dept. of Library & Information Science, Vikrant University, Gwalior, MP, India

and

Prof. Dr. Dharam Vir Singh

Department of Library and Information Science, Vikrant University, Gwalior, MP, India

*Corresponding Author: Dibakar Das
Affiliation: Librarian, Sripat Singh College
Contact No.: 8348854054
Email: dkdibakardas@gmail.com

Abstract:

Bibliometric analysis is a statistical method used for the analysis of collected data and to examine its features, advancements, and forecast future trends. We conducted a bibliometric analysis of the articles published in the Journal of Chemical Sciences. The data is collected from The Journal of Chemical Sciences, which includes 769 national and international research papers published from 2021 to 2025. The obtained data is analyzed by using the tools suxh as mean, median and mode. This study identifies the research trends in chemical sciences, authorship patterns, and citation. Five years trend of publishing output and research trends in chemical sciences are shown in this article. Moreover, this study applies citation analysis to identify productive authors, important papers, and sources. Beside this, the study identifies the contributions of countries, the authorship and co-authorship analysis. From this research, it is also revealed that India is one the countries with the great degrees of affiliation. This study showed that the authors and co-authors of the collected articles are ranging from two to nine. Therefore, we anticipate that the findings of this paper will benefit for all researchers with an interest in this field.

Keywords: Authorship Pattern, Bibliometric Analysis, Chemical Sciences, Citation Analysis, Research Trends.

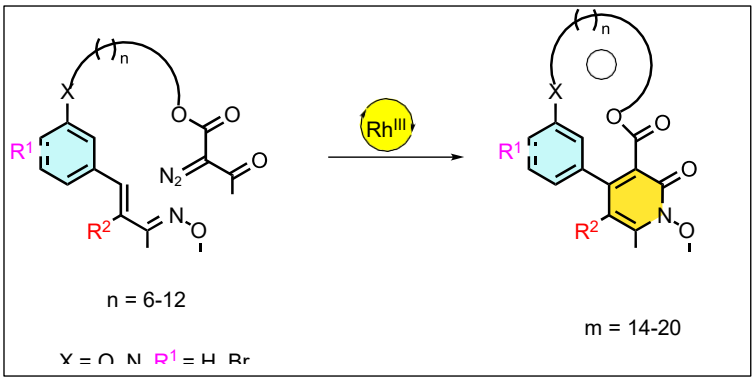
Rh(III)-Catalyzed Construction of 2-Pyridone Cyclophane Type Macrocycles

Tapan Kumar Pradhan*[1], Sanhita Sarkar[2], Sayan Shom[2], Rajarshi Samanta*

[1] Department of Chemistry, Murshidabad University, Murshidabad, W. B., India
[2] Department of Chemistry, Indian Institute of Technology Kharagpur, Paschim Midnapur, W. B., India
Presenting author's e-mail: tkpche@msduniv.ac.in

Abstract:

A growing molecular complexity in modern drug targets has created an increasing demand for therapeutic agents larger than traditional small molecules. Macrocycles represent a vital class of compounds with long-recognized importance in chemical biology and drug discovery.[1]In recent times, substantial advances have been made in synthetic and biological strategies for constructing large ring systems composed of amino acid residues, long chains, and heterocycles.Transition-metal-catalyzed directed C–H bond functionalization has been explored for the construction of such macrocycles, predominantly through the intramolecular coupling of aryl halides and arene C–H bonds.[1-2]



In this report, the construction of cyclophane-type macrocycles with 2-pyridone scaffolds has been studied via the directed migratory insertion of Rh^{III}metal carbenes,affording interesting macrocycles.This intramolecular method involves directed C–H metalation, metal–carbene formation, and migratory insertion to generate novel molecules. The application of this method is showcased by several examples featuring different long chains, aromatic parts, and various leaving groups.

References:

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Molecular Characterization and Species Authentication of Commercially Available Medicinal Plant Derived Products: An Application of DNA Barcoding for Quality Control and Consumer Safety

Bhaskar Mallick[1], Zisan Ahamed[1], Ashis Kumar Panigrahi[2], Sushil Kumar Mandal[1*]

[1] Dept. of Ecological Studies, University of Kalyani, Kalyani, Nadia – 741235
[2] Dept. of Zoology, University of Kalyani, Kalyani, Nadia – 741235
*Contact – 9433497249 *Email Id – sushilestu18@klyuniv.ac.in

Abstract:

Herbal medicines are used worldwide in complementary and alternative healthcare as well as they have been used for centuries in various traditional systems of medicine like AYUSH, TCM, KAMPO, etc. In India, the medicinal herbs are one of the most rapidly expanding segments of alternative medicine sector. Currently adulteration in the raw herbal trade has been a long-standing issue, affecting both product quality and consumer safety. Previously, plant species were authenticated based on their phenotype which involved the experienced skills of a professional taxonomist but there is a lack of clear botanical standards to verify the quality of medicinal plant and products based on it. This gap limits proper quality control, affecting the safety and effectiveness of herbal drugs. To address these limitations, DNA barcoding offers a reliable and precise approach to authenticating medicinal plant and medicinal plant-derived products. It also helps to ensure consumer safety and product quality in the market. In this research, out of 12 medicinal plant-derived products, 1 produced no genomic DNA and not amplified in PCR. The remaining 11 samples were amplified using rbcL primer and sequencing was done. After the analysis of 11 sequences of herbal products, 7 samples were found to be authentic and validated by sequencing, further submitted to NCBI for phylogenetic analysis and the 3 verified medicinal plant barcode sequences were used to generate the reference DNA library. The remaining 4 sequences were found to be mislabelled samples. These findings show that herbal products misidentification is common and these multi-species admixtures can jeopardise quality control, pharmacological consistency and consumer safety.

Keywords: DNA barcoding, rbcL primer, Adulteration, Molecular authentication, Quality control.

Insight into Supramolecular Networks Engineered via Cooperative Effects of Tetrel and Hydrogen Bonding Interactions in Pb(II) Complexes

Suman Adhikari
Department of Chemistry, Govt. Degree College, Dharmanagar, Tripura(N)-799253, India

Abstract:
Supramolecular chemistry is a multidisciplinary field that focuses on the study of non-covalent interactions between molecules, leading to the formation of complex structures and assemblies. Van der Waals interactions, π-stacking, cation/anion···π interaction and hydrogen bonds are some of the most well-known non-covalent forces that have been recognized for their crucial contributions to supramolecular self-assembly. Other non-covalent interactions like tetrel (TtBs), pnictogen, spodium, chalcogen, aerogen, and even regium bonding are emerging as new participants in this arena. The σ-hole interaction is currently one of the fascinating aspects of supramolecular chemistry and is signified by tetrel, pnictogen, chalcogen, and halogen bonds, respectively, and is commonly found in Group 14 to 17 elements. The TtBs is a new kind of non-covalent interaction that, in large-scale systems, unites two or more molecular units to form a supramolecular assembly. The TtBs result in complicated chemical systems when Group 14 elements in molecules function as electrophilic sites for nucleophilic sites in the solid, liquid, and gas phases. TtBs bonds serve as novel molecular linkers because they are extremely directed and have strength similar to H-bonds and other σ-hole-based interactions. Therefore, a comprehensive understanding of new types of non-covalent/intermolecular forces, which form the basis of rational design, has enabled the scientific community to manage and use matter at a level of complexity never before possible. In essence, supramolecular chemistry will generally convey how specific non-covalent interactions lead to the formation of a particular molecular assembly, and what useful properties or functions that assembly possesses.
Keywords: Supramolecular networks; lead(II); tetrel bonds; hydrogen bonds; cooperativity effects.

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Development Versus Environmental Sustainability in India: An Analytical Study of Policy Trade-Offs and Ecological Consequences

Tribeni Roy (Presenting Author), Sayan Das, Dr. Debjani Mandal, Dr. Abhishek Basu
Department of Molecular Biology and Biotechnology, Sripat Singh College, Murshidabad, India
Corresponding Author: Dr. Abhishek Basu
Affiliation: Department of Molecular Biology and Biotechnology,
Sripat Singh College, P.O. Jiaganj, Murshidabad,
West Bengal: 742123, India.
Email: abasu@sripatsinghcollege.edu.in

Abstract:

Modern medicine has achieved monumental success in reducing mortality through the development of vaccines, antibiotics, and improved sanitation. However, infectious diseases persist because medical progress, while controlling infections, does not eliminate the fundamental reality of microbial evolution. This presentation explores the microbiological and anthropogenic factors that allow pathogens to thrive despite advanced healthcare. A primary driver is the rapid evolution of microorganisms, such as bacteria that divide every 20 to 30 minutes, allowing genetic mutations to outpace the development of new drugs. This natural resilience is exacerbated by human behaviors, including the misuse of antibiotics—such as stopping treatments prematurely or using them for viral infections—which directly facilitates the rise of antimicrobial resistance. Furthermore, the contemporary landscape of infection is shaped by emerging zoonotic diseases, global travel, and environmental shifts like climate change and urbanization. Clinical settings also present unique challenges through nosocomial infections that target immunocompromised patients via contaminated instruments or drug-resistant strains. Individual host factors, including chronic stress and poor nutrition, further weaken immune defenses. Ultimately, this study underscores that while medicine treats infection, the field of microbiology is essential for identifying pathogens and monitoring resistance patterns. Effective infection control requires a synergy of laboratory research, public awareness, and responsible antibiotic stewardship to protect global public health.

Keyword: Microbial evolution, Antimicrobial resistance, Nosochemical infection, Zoonosis, Antibiotic stewardship

Sustainable Solvent Technologies for Cleaner Chemical Production

Dr. Amit Kumar Kundu
(Assistant Professor)
Department of Chemistry, Sripat Singh College, Murshidabad, West Bengal, India
Email: akkundu@sripatsinghcollege.edu.in

Abstract:

The rising demand for environmentally dependable chemical production has strengthened attention in sustainable solvents and reaction media as alternatives to conventional, environmentally hazardous solvents. Traditional organic solvents, though indispensable in industrial and laboratory processes, are usually related with toxicity, volatility, resource depletion, and environmental contamination. On the other hand, green solvents are considered to reduce ecological and human health risks without compromising operational efficiency. Typically obtained from renewable feedstocks or engineered for minimize toxicity and improved biodegradability, these solvents promotes the principles of green chemistry and sustainable development.

The present study investigates the classification, physicochemical characteristics, and practical applications of environmentally benign solvents across various chemical processes. The major categories discussed include bio based solvents, supercritical carbon dioxide, ionic liquids, deep eutectic solvents, and certain fluorinated media, all of which delivers unique benefits such as developed safety profiles, better recyclability, adaptable physicochemical properties, and minimal environmental impact. Their roles in solvent extraction, organic transformations, polymer synthesis, and industrial cleaning operations are examined in depth. Along with decreasing emissions and harmful waste generation, green reaction media often develop reaction rates, product selectivity, and energy efficiency. Whereas challenges associated with economic feasibility, macro scale implementation, and lifecycle assessment persist. Current technological innovation and interdisciplinary research are intensifying their industrial viability. The integration of green solvent systems into mainstream chemical practice embodies a fundamental step toward cleaner production, resource conservation, and long term environmental stewardship. Sustained growth in this field will play a key role in transforming the chemical sector to better correspond with worldwide sustainability objectives.

Kerwords: sustainable solvents, minimize toxicity, biodegradability, recyclability, economic feasibility

বৈজ্ঞানিক গবেষণায় নীতিশাস্ত্র ও দায়বদ্ধতা : একটি তাত্ত্বিক ও প্রায়োগিক বিশ্লেষণ

ইসমাইল সেখ
Department of Political Science, Sripat Singh College, Murshidabad, West Bengal, India

Abstract:

বৈজ্ঞানিক গবেষণা জ্ঞান উৎপাদনের অন্যতম প্রধান মাধ্যম হলেও এর গ্রহণযোগ্যতা ও সামাজিক প্রাসঙ্গিকতা অনেকাংশে নির্ভর করে নীতিশাস্ত্র ও গবেষকের দায়বদ্ধতার উপর। বর্তমান একুশ শতকে বিজ্ঞানের জয়যাত্রা মানবসভ্যতাকে অভূতপূর্ব সাফল্যের শিখরে পৌঁছে দিয়েছে।তবে এই অগ্রগতির সমান্তরালে গবেষণার গুণগতমান, স্বচ্ছতা এবং নৈতিকতা বজায় রাখার বিষয়টি বিশ্বজুড়ে এক গভীর উদ্বগের জন্ম দিয়েছে। আধুনিক জ্ঞানচর্চায় গবেষণা কেবল তথ্য সংগ্রহ বা তথ্য নির্মাণের প্রক্রিয়া নয়,বরং এটি একটি দায়িত্বপূর্ণ সামাজিক কর্মকাণ্ড। এই গবেষণাপত্রে বৈজ্ঞানিক গবেষণায় নীতিশাস্ত্র ও দায়বদ্ধতার বিষয়টি তাত্ত্বিক ও প্রায়োগিক উভয় দৃষ্টিকোণ থেকে বিশ্লেষণ করা হয়েছে। বিজ্ঞানের লক্ষ্য কেবল নতুন আবিষ্কার নয়,বরং সেই আবিষ্কারের প্রক্রিয়াটি কতটা ন্যায়নিষ্ঠ, তার ওপরই বিজ্ঞানের সামগ্রিক গ্রহণযোগ্যতা নির্ভর করে।

এই গবেষণার প্রাথমিক অংশে নীতিশাস্ত্রের মৌলিক উপাদান- সততা,নিরপেক্ষতা, স্বচ্ছতা,অংশগ্রহণকারীর সম্মতি, জবাবদিহিতা, তথ্যের সুরক্ষা,গোপনীয়তা রক্ষা ইত্যাদি বিষয় সমূহকে তাত্ত্বিকভাবে আলোচনা করা হয়েছে। পাশাপাশি বৈজ্ঞানিক সততা,গবেষকের পেশাগত নৈতিকতা এবং প্রাতিষ্ঠানিক নীতিমালার পারস্পরিক সম্পর্কও উপস্থাপন করা হয়েছে। গবেষণার দ্বিতীয় অংশে বিভিন্ন ক্ষেত্রভিত্তিক দৃষ্টান্তের দ্বারা গবেষণায় অর্থনৈতিক চর্চা, যেমন-তথ্যবিকৃতি, প্লাগারিসম, ডেটা ম্যানিপুলেশন,ভুয়ো গবেষণা ফলাফল প্রকাশ, স্বার্থের সংঘাত এবং গবেষণায় ক্ষমতার অপব্যবহার, পক্ষপাতমূলক বিশ্লেষণ ইত্যাদি তুলে ধরা হয়েছে। আবার একইসঙ্গে গবেষণা তহবিল, প্রকাশনাজনিত চাপ এবং প্রতিযোগিতামূলক একাডেমিক পরিবেশ কিভাবে নৈতিক ঝুঁকি বাড়ায় ,তা বিশ্লেষণ করা হয়েছে।

গবেষণা প্রতিষ্ঠান, নীতিনির্ধারক সংস্থা, জার্নাল এবং গবেষকদের পারস্পরিক দায়বদ্ধতার কাঠামোও এখানে আলোচিত হয়েছে, যা একটি সুসংহত নৈতিক পরিবেশ গঠনে গুরুত্বপূর্ণ ভূমিকা সম্পাদন করে। এই গবেষণায় দেখানো হয়েছে যে, বৈজ্ঞানিক গবেষণায় নৈতিকতার অভাব কেবল গবেষণার মানকেই ক্ষতিগ্রস্ত করেনা, বরং জ্ঞানব্যবস্থার প্রতি সামাজিক আস্থাকে দুর্বল করে এবং নীতি নির্ধারণ প্রক্রিয়াকেও বিভ্রান্ত করতে পারে। তাই একটি কার্যকর গবেষণা নৈতিক কাঠামো প্রতিষ্ঠার জন্য প্রয়োজন নৈতিক শিক্ষা, প্রাতিষ্ঠানিক নজরদারি,কঠোর নীতিমালা এবং গবেষকদের মধ্যে নৈতিক সচেতনতার বিকাশ। তাই তাত্ত্বিক নৈতিক মূল্যবোধ ও প্রায়োগিক দায়বদ্ধতার সমন্বয়ের মাধ্যমেই বৈজ্ঞানিক গবেষণাকে আরোও মানবিক, স্বচ্ছ ও বিশ্বাসযোগ্য করে তোলা সম্ভব, যা দীর্ঘমেয়াদী টেকসই জ্ঞানচর্চা ও সামাজিক কল্যাণে গুরুত্বপূর্ণ অবদান রাখবে ।

Keywords: গবেষণা নীতিশাস্ত্র, নৈতিক দায়বদ্ধতা, তথ্যের সত্যতা ও স্বচ্ছতা, প্লাগারিসম ও অ্যাকাডেমিক অসদাচরণ, স্বার্থের সংঘাত ব্যবস্থাপনা, গবেষণায় অংশগ্রহণকারীর অধিকার ও সুরক্ষা

The NEP- 2020 Framework and Buddhist Morality: A Critical Analysis

Dr. Debjani Mandal, Priyanka Pal, Saptaparna Kundu, Rupa Khatun, Nandan Sinha, Dr.Abhishek Basu

Department of Molecular Biology and Biotechnology, Sripat Singh College, Murshidabad, West Bengal, India

Corresponding Author: Dr. Abhishek Basu
Affiliation: Sripat Singh College, Murshidabad, West Bengal, India
Email: abasu@sripatsinghcollege.edu.in

Abstract:

Arsenic Hyper-tolerant Bacterium DACW8 is isolated from arsenic contaminated soil and identified by 16S rDNA gene sequencing followed by subsequent phylogenetic analysis as Enterobacter sp. Scanning electron microscopic analysis depicted that DACW8 is a gram-negative, rod-shaped, white, smooth surfaced bacterium with a size of 1.2 µm. The colonies of the isolated bacterium are hyper-tolerant to arsenite, arsenate and iron, surviving in 16 mM arsenite, 241 mM arsenate and 220 mM iron (Fe^{+2}), respectively. DACW8 is a fast-growing bacterium which shows similar growth patterns in Luria Bertani (LB) Broth medium amended with 100 ppm sodium arsenite, 500 ppm sodium arsenite, 1000 ppm sodium arsenite due to its hyper-tolerance to arsenic stress. At 2000 ppm sodium arsenite (which is close to the Minimum Inhibitory Concentration), the growth of the bacterium slows down. The bacteria can grow at high concentration of arsenic so there could be some assimilatory (accumulation of arsenic) and dissimilatory (use of arsenic for metabolic reactions) that prompted us to check its biotransformation potential. DACW8 also shows biotransformation potential as it can convert arsenite to arsenate which is less toxic form. The colonies of bacterial strain DACW8 turned brown in agar Luria Bertani (LB) Broth medium supplemented with 7.697 mM arsenite (1000 ppm sodium arsenite) when incubated with silver nitrate solution. The brown colour formed due to the formation of silver arsenate. Bioremediation potential of this bacterium could be used for remediation of arsenic toxicity in groundwater and wastewater.

Keywords: 16S rDNA sequencing, Phylogenetic analysis, Scanning electron microscopy, Biotransformation, Bioremediation

Different Approaches to Biodiversity Conservation

Sunita Hansda
(Assistant Professor)
Department of Zoology, Sripat Singh College, Murshidabad, West Bengal, India
E-mail: shansda@sripatsinghcollege.edu.in

Abstract:

The preservation of biodiversity is essential to the ecosystem's long-term viability. In addition to protecting various animal species, their habitats, and ecosystems, conservation also preserves ecological equilibrium and biodiversity. Preserving species diversity, protecting genetic diversity, and ensuring ecological sustainability are the primary goals of biodiversity conservation. The two most important types of conservation strategies are in-situ and ex-situ conservation. Ex-situ conservation involves protecting animals outside of their natural habitats, and in-situ conservation involves conserving animals within their wildlife habitat. In addition to these two tactics, people should create or implement a number of other methods to enhance the ecosystem's sustainable development, such as recovery and captive breeding programs, community-based conservation, anti-poaching and wildlife protection laws, research, education, and public awareness, and habitat protection and restoration. The creation of many national parks and reserve forests safeguards the environment. The animals will be protected by stricter laws against animal trafficking, drone and GPS surveillance, and bans on international trading. Ecosystem management is greatly aided by community-based initiatives such as ecotourism, Indigenous land management programs, and sustainable agriculture methods. The various wildlife conservation strategies that are crucial to the ecosystem's long-term viability will be covered in this article.

Keywords: Biodiversity conservation, Ex-situ conservation, In-situ conservation, Captive breeding, Ecotourism.

Identification of Geochemical Factors Responsible for Arsenic Release and Mobilization in Irrigation Well Water: A Case Study in Rural Bengal

Arighna Sarkar, Dr. Abhishek Basu*

Department of Molecular Biology and Biotechnology, Sripat Singh College, Murshidabad, West Bengal, India

*Corresponding Author: Dr. Abhishek Basu
Affiliation: Sripat Singh College, Murshidabad, West Bengal, India
Email: abasu@sripatsinghcollege.edu.in

Abstract:

This study investigates groundwater quality in irrigation wells of Chakdaha block, Nadia district, West Bengal—part of the Ganges-Brahmaputra-Meghna deltaic alluvium. The region, characterized by flat terrain and intersected by rivers and channels, supports intensive agriculture, particularly boro rice cultivation. Forty irrigation wells, installed between 1985 and 2010 and ranging from 15 to 42 meters in depth, were sampled during the pre-monsoon season (March–May), when irrigation demand is highest.

Groundwater analysis revealed a reducing environment with low dissolved oxygen and elevated levels of redox-sensitive elements. The average arsenic concentration was 58.7 µg/L, while total iron averaged 2.6 mg/L. High concentrations of calcium (252.0 mg/L), magnesium (96.9 mg/L), and alkalinity (400.3 mg/L) suggest active carbonate dissolution, particularly of calcite and dolomite. Sulphate and nitrate were present in lower concentrations, averaging 8.3 mg/L and 1.8 mg/L respectively.

Factor analysis was employed to explore correlations among hydrochemical parameters. A strong positive correlation ($r^2 = 0.716$) between arsenic and iron indicates a geochemical linkage likely driven by reductive dissolution of iron oxides. This statistical approach identified dominant geochemical processes influencing arsenic mobilization.

The hydrochemical profile reflects a complex interplay of natural geochemical processes and anthropogenic influences. These findings highlight the importance of integrated chemical and statistical approaches to understand arsenic mobilization in groundwater, especially in rural Bengal where irrigation practices pose environmental and health risks.

Keywords: Groundwater, Arsenic, Hydrochemistry, Factor Analysis, Irrigation Wells

Scientific Reconstruction of the Past: Archaeological Science and the Dynamics of Sustainable Societies in Early South Asia

Dr. Jappen Oberoi
Historian
Chandigarh

Abstract:

This paper examines how archaeological science facilitates the scientific reconstruction of sustainable societal dynamics in early South Asia through systematic analysis of material remains. Bringing together epigraphy, palaeography, numismatics, metrology, metallurgical composition, ceramic typology, stratigraphy, and archaeometric dating, it seeks to identify measurable indicators of long-term structural viability within early socio-economic formations. Statistical evaluation of coin weights and alloy composition is employed to assess economic standardisation, resource calibration, and responses to material constraint. Epigraphic corpora are analysed for evidence of fiscal regulation, agrarian organisation, and water management, while palaeographic continuity provides relative chronological control over administrative persistence. Stratified ceramic assemblages and radiometric dating further establish patterns of settlement continuity, disruption, and adaptive recalibration across extended temporal horizons. Rather than approaching sustainability as a retrospective normative construct, the study treats it as an empirically demonstrable condition: the capacity of interdependent economic, environmental, and institutional systems to regulate resources, absorb stress, and maintain systemic coherence over time. Processual models of systemic interaction are considered alongside post-processual attention to governance, agency, and symbolic authority, permitting a layered interpretation of resilience within early polities. By integrating quantitative measurement with contextual archaeological analysis, the paper argues that scientific reconstruction provides a rigorous framework for identifying the dynamics of sustainable societies beyond the limitations of textual historiography alone. In doing so, it situates contemporary sustainability discourse within a materially grounded, long-duration historical perspective.

Keywords: Archaeological science, epigraphy, numismatics, archaeometry, sustainable societies

Impacts of Deforestation on Biodiversity and Its Conservation Policy Under the Jurisdiction of Karbi Anglong Autonomous Council, Assam

Prabin Engleng
(Assistant Professor)
Department of Political Science, Rangapara College (Autonomous), Sonitpur District, Assam, India
Email id: prabinengleng@gmail.com

Abstract

Deforestation means the large-scale removal of trees from forested areas. It often leads to the conversion of land for agriculture, mining, urbanization, and other development purposes. Diverse types of forest are found in the Karbi Anglong district, consisting of tropical moist semi-evergreen forests, moist mixed deciduous forests, riverine forests, and subtropical broadleaf hill forests. In these forest areas, it encompasses plenty of diverse flora and fauna. Biodiversity refers to the diverse variety of plants, animals along with microorganisms living in a particular region. It helps to enhance fresh air, water, food, medicinal health, eco-tourism and resist to climate change. As per the assessment of 2019, the total forest covered about 7,983 sq. km, with 76.5% of the geographical area in the Karbi Anglong district. However, massive expansion of agriculture and urbanization has destroyed trees and forest land, which leads to deforestation. The main reasons behind the deforestation are overgrazing, illegal logging, coal, sand, and rock mining, cement and brick factories, agriculture, overpopulation, and jhum cultivation. As a result, this deforestation has led to the loss of animal habitats, loss of biodiversity through species decline and extinction, ecological imbalance, increased man-animal conflicts, soil erosion, global warming, and climate change. Overall, it can be observed that 97.4 kilo hectares (12%) decreased tree cover and 32 kilo hectares (11%) lost primary forest in 2024 in the Karbi Anglong District. To protect and preserve the forest and flora and fauna, the K.A.A.C. government has reserved five wildlife sanctuaries, two elephant reserves, and seventeen district council reserved forests. It also initiated professional grazing reserve and village grazing reserve land to prevent deforestation. This paper aims to analyse the causes of deforestation and conservation policy under the jurisdiction of K.A.A.C.

Keywords: Deforestation, Karbi Anglong, Biodiversity, Forest, Jhum cultivation, KAAC

Exploring Pedagogical Innovation Education

Dr. Shibu Paul
(Assistant Professor)
Department of Political Science, Sripat Singh College, Murshidabad, West Bengal, India
E-mail: shibupaul1983@gmail.com

Abstract:

Pedagogical innovation in education refers to the process of introducing new and creative approaches to teaching and learning. This paper highlights the importance of innovation in pedagogy, its benefits, and the various strategies that can be employed to foster innovative teaching practices. - Technology integration, flipped classrooms, gamification, and project-based learning. It will enhance student engagement, improved learning outcomes, and development of critical thinking and problem-solving skills. Pedagogical innovation is essential for creating engaging and effective learning environments. By embracing innovative teaching strategies, educators can improve student outcomes and prepare learners for success in an ever-changing world. This abstract provides a foundation for exploring the role of pedagogical innovation in education and its potential to transform teaching and learning practices. At the same time, there are some limitations like resistance to change, limited resources, and the need for teacher training and support.

Keywords: Pedagogy; technology; project-based learning; challenges

Isolation and Characterization of Arsenic Hyper-Tolerant bacteria from groundwater of Bhagwangola II block of Murshidabad district, West Bengal

Manali Biswas, Dr. Abhishek Basu*
Department of Molecular Biology and Biotechnology, Sripat Singh College, Murshidabad, West Bengal, India
*Corresponding Author: Dr. Abhishek Basu
Affiliation: Sripat Singh College
Email id - abasu@sripatsinghcollege.edu.in

Abstract:

An Arsenic hyper-tolerant bacterium was isolated from groundwater of Notun Madanpur of Bhagwangola II block of Murshidabad district, West Bengal. The bacterium was biochemically characterized and identified by scanning electron microscopy, 16S rDNA sequencing, subsequent phylogenetic analysis, and whole genome sequencing as *Acenetobactor junii*. The bacterium showed unprecedented tolerance to Arsenic and hyper-tolerance towards other heavy metal such as Cu^2, Pb^{2+} and Mn^{2+}. The isolated bacterium exhibited unhindered growth at 1000 ppm of Sodium Arsenite and capable of bioremediation and biotransformation of arsenite (III). *Acinetobacter junii* also showed plant growth-promoting properties like N_2 fixation, auxin and ammonia production. These dual potential of the isolated bacterium could be applied for remediation and nourishment of arsenic-infested soil.

Keywords: Bioremediation, Whole Genome Sequencing, *Acinetobactor junii*, 16s rDNA, Biotransformation.

Nucleation-Governed Architectural Engineering of Metal/Metal Oxide Nanostructures for Sustainable Catalysis and Energy Conversion

Abu Raihan
(Research Scholar)
Department of Chemistry, University of Kalyani, Nadia, West Bengal, India
E-mail: abuchem22@klyuniv.ac.in

Abstract:

Metal/Metal Oxide Nano-structures made of noble metals (Pt, Ag, Au etc.) and metal oxides (TiO_2, ZnO and Fe_2O_3 etc.) have gained a substantial interest to be employed in Chemo selective hydrogenation, Photo induced water oxidation, surface enhanced Raman spectroscopy, photocatalysis, Surface Plasmon Resonance, solar cells, drug delivery, and many other vital fields. One of the essential aspects driving the physical characteristics of metal/metal Oxide nano-structures is the overall architecture of the nano-structures. Metal oxides are combined with metals to give a variety of nano-structures, such as Janus metal/metal oxide nano-structures, nanoarrays, metal oxide embellished with metallic nanoparticles, metal/metal oxide yolk/shell and metal oxide/noble metal core/shell. Instead of modulating the stacking of the metal, one can control the size of the metal nanoparticles by adjusting the speed at which the solution containing metal ions is injected. The formed nano-structures possess a stable structure and a high metal yield. The size-control strategies and synthesis, both be used to build multiple nano-structures. The different produced nanostructures show improved catalytic performance for hydrogenation processes in aqueous media depending on the size of the engaged metal particle.

Keywords: Metal-Oxide nano-structures; Metal/Metal Oxide; Inorganic Materials, Hydrothermal Synthesis

Progress in Heterocyclic Schiff Base Chemistry: Synthesis, Functionalization, and Medicinal Applications of Their Metal Complexes

Manirul Mandal*, and Dr. Mossaraf Hossain[2]

[1] Synthetic Organic Research Laboratory at MMTTC (HRDC),
Department of Chemistry, University of North Bengal, Siliguri,
Darjeeling, 734013
[2] Synthetic Organic Research Laboratory, UGC-MMTTC (HRDC),
University of North Bengal, Siliguri, Darjeeling, 734013
*Email: manirul.mandal1@gmail.com

Abstract:

The Extensive prevalence of nitrogen-containing heterocycles in biologically active molecules has accelerated progress in innovative synthetic methodologies. Among these, the chemistry of heterocycle and heteroclic frameworks has been comprehensively explored due to their outstanding structural diversity and Broad-spectrum biological activities. Heterocyclic systems presenting quinazolinone, imidazole, triazole etc. moieties and their Schiff base ligands (SBLs) hold one of the most importance in medicinal chemistry, displaying diverse pharmacological activities such as antimicrobial, antibacterial, anti-inflammatory, anticancer, antifungal, central nervous system (CNS) modulatory, antimalarial, antitumor, and adenosine receptor antagonistic properties. Recent studies have also highlighted their potential as organic electropolishing (EP) inhibitors, demonstrating their utility beyond biomedical contexts.

The attachment of the imine (–CH=N–) linkage in heterocycle-based Schiff bases enhances electron delocalization and coordination capability, making these ligands highly adaptable for complex formation with transition metals. The resulting Schiff base metal complexes (SBMCs) often show superior biological activities, including anti-HIV, anticancer, antioxidant, and antileishmanial effects, due to synergistic metal–ligand interactions. Although several heterocycle-derived Schiff bases and their metal complexes have been synthesized, there remains a continuing need to design and progress new derivatives through rational modification of substituents to optimize electronic and steric effects. Recent advances in green and sustainable synthetic methodologies have further expanded opportunities for environmentally friendly production of these bioactive frameworks.Therefore, researchers aim to provide a comprehensive overview of the structural features, synthesis, and antibacterial properties of heterocycle and its Schiff base derivatives, highlighting there in vitro and in vivo pharmacological activities as well as the underlying structure–activity relationships (SARs) that govern their biological efficacy.

Integrated AI–CRISPR Framework for Climate-Resilient Crop Engineering

Sathi Das, Shrabana Banerjee (Presenting Author), Sagar Mondal (Presenting Author), Aparna Maity (Presenting Author), Dr. Debjani Mandal, Dr. Abhishek Basu*

Department of Molecular Biology and Biotechnology, Sripat Singh College, Murshidabad, West Bengal, India

*Corresponding Author: Dr. Abhishek Basu

Affiliation: Sripat Singh College

Email id - abasu@sripatsinghcollege.edu.in

Abstract:

Climate change and escalating global food demand mandates innovative strategies to engineer crop varieties with enhanced resilience to both biotic (disease) and abiotic (drought) stresses. Recent advances in CRISPR-Cas genome editing have demonstrated the feasibility of precisely modifying stress-responsive genes to generate crops with improved tolerance, hence bypassing the limitations of traditional breeding cycles, therefore enabling targeted manipulation of genetic networks that govern stress responses. CRISPR-mediated disruption or modulation of candidate genes such as (ethylene response) ARGOS8 in maize, (prevention from Bacterial Blight) OsSWEET14 in super basmati, and stress signalling components in tomato has produced exceptional phenotypes, underscoring the potential of gene-editing approaches in developing climate-resilient cultivars.

However, current CRISPR efforts largely focus on single gene edits in isolated conditions, neglecting the real multigenic nature of complex stress tolerance traits. There seems to be a critical need for validating edits in realistic field scenarios. Integrating AI-designed gene editors such as; novel Cas variants tailored for crop genomes with big data-driven trait prediction can enable the rational selection of multi-gene editing targets.

Simultaneously, advances in high-efficiency and autonomous phenotyping platforms would facilitate scalable assessment of edited lines across diverse environmental conditions, providing feedback for iterative model refinement. By combining predictive AI models, new variants of CRISPR tools, and autonomous phenotyping systems, we propose an automated system that'd accelerate design, and evaluation of seed-level genome edits aimed at drought and disease resistance. This will not only bridge the computational prediction with validation but also set the stage for precision crop engineering to meet future agricultural challenges.

Keywords: CRISPR, Multi-gene Editing, Predictive AI models, Resilient Crops, Autonomous Phenotyping System**.**

Small Molecular Antimicrobial Ligands of YspD are Potential Therapeutic Agents Against Yersinia enterocolitica Infection

Pritha Shil, Shreya Bhatta, Anjali Thakur, Debjani Mandal, Abhishek Basu*

Department of Molecular Biology and Biotechnology, Sripat Singh College, Murshidabad, West Bengal, India

*Corresponding Author: Dr. Abhishek Basu
Affiliation: Sripat Singh College
Email id - abasu@sripatsinghcollege.edu.in

Abstract:

Yersinia enterocolitica remains a formidable enteric pathogen, utilizing the Ysa-Ysp Type III Secretion System (TIIISS) to bypass host immune defenses via the injection of effector toxins. Central to this virulence mechanism is YspD, a hydrophilic translocator protein that facilitates the assembly of the functional translocon at the needle tip. Given its essential role in pathogenesis and its accessibility within the extracellular milieu, YspD represents a high-value therapeutic target for anti-virulence intervention. We utilized a multi-platform computational pipeline to identify druggable motifs within YspD and screen potential small-molecule inhibitors. DoGSiteScorer and COACH metaservers identified nine potential pockets, with Pocket-0 (P0) emerging as the most viable druggable site (Drug Score: 0.82). P0 is strategically located within the evolutionarily conserved intramolecular coiled-coil region (Helix-5 and Helix-9), which is critical for YspD multimerization and its interaction with the hydrophobic translocator YspB. Molecular docking via SwissDock and Achilles Blind Docking was performed on a library of known TIIISS inhibitors. Two candidates, Salicylidene Acyl Hydrazide derivative (INP0400) and Phenoxyacetamide derivative (MBX1641), demonstrated superior binding affinities (ΔG of -8.24 kcal/mol and -7.57 kcal/mol, respectively) compared to clinical controls. Analysis of the docking poses revealed stable hydrophobic interactions and hydrogen bonding with key residues, including Phe289, Ala119, and Trp189, effectively masking the interfaces required for translocon maturation. These findings provide a structural blueprint for the development of "pathoblocker" therapies that attenuate Yersinia virulence without the selective pressure of conventional antibiotics, offering a promising strategy to combat antimicrobial resistance.

Keywords: Yersinia enterocolitica • Ysa-Ysp T3SS • YspD Translocator • Pathoblockers • Molecular Docking

Embedding Sustainability in University Classrooms: Aligning Higher Education with the Global Development Agenda

Animesh Das

Guest teacher of Department of Geography, Murshidabad University, Murshidabad, West Bengal, India
E-mail: dasanimesh546@gmail.com

Abstract:

This research investigates the imperative of embedding sustainability within university classrooms as a critical mechanism for aligning higher education with the global development agenda. As nations worldwide intensify their commitments to sustainable development—particularly through landmark frameworks such as the United Nations' Sustainable Development Goals (SDGs)—higher education institutions (HEIs) are uniquely positioned to catalyze transformative change. This study posits that universities must transition beyond traditional knowledge transmission to become proactive agents of sustainability through curricular, pedagogical, and institutional innovations that prepare graduates with the competencies required to address complex socio-ecological challenges.

The central objective of this research is to examine how sustainability is currently integrated into university curricula, identify the barriers and enablers influencing effective implementation, and propose a conceptual model for systemic adaptation that aligns classroom practices with broader development priorities. Employing a mixed-methods research design, the study synthesizes quantitative survey data from faculty, administrators, and students with qualitative insights derived from in-depth interviews, curriculum content analysis, and institutional case studies across diverse geographic and disciplinary contexts. This multi-layered approach enables a comprehensive understanding of both the structural and pedagogical dimensions of sustainability education in higher learning environments.

Findings from the study reveal a significant disparity between institutional sustainability rhetoric and classroom practice. While many universities have adopted sustainability Statements and strategic plans, integration within disciplinary curricula remains inconsistent, often limited to optional modules or peripheral topics. Faculty perceptions indicate that insufficient institutional support, lack of pedagogical training, and rigid disciplinary silos impede systemic integration. Conversely, the study finds that supportive leadership, cross-disciplinary collaboration, and targeted professional development significantly enhance the capacity for embedding sustainability education. Students who engaged with sustainability-

focused coursework reported higher levels of agency, systems-thinking capabilities, and commitment to community engagement—outcomes that are essential for fostering sustainable mindsets.

The research contributes to theoretical scholarship by articulating a multi-dimensional framework that reconceptualizes sustainability embedding not merely as curriculum content but as an epistemological shift in teaching and learning. This framework emphasizes the integration of sustainability competencies—such as ethical reasoning, futures thinking, and transdisciplinary problem-solving—across formal, informal, and co-curricular learning spaces. Additionally, the study highlights the importance of aligning university assessment practices with authentic sustainability outcomes, advocating for the inclusion of community-engaged projects, reflective praxis, and real-world problem analysis as core evaluative components.
In policy terms, the study offers evidence-based recommendations for educational leaders and policymakers to strengthen institutional strategies, revise accreditation standards, and incentivize pedagogical innovation that prioritizes sustainability. By embedding sustainability into the heart of university teaching and learning, higher education can more effectively fulfill its role in advancing the global development agenda and equipping future leaders capable of navigating and transforming an increasingly interconnected and resource-constrained world. The research ultimately asserts that the true measure of sustainability education lies not only in curricular inclusion but in the cultivation of graduates who embody sustainable values and contribute to equitable and resilient global futures.

Keywords: Sustainability Education; Higher Education Institutions (HEIs); Global Development Agenda; Sustainable Development Goals (SDGs); Curriculum Integration; Transformative Learning

Education as a Catalyst for Sustainable Development: Pedagogical Pathways toward the SDGs

Soumi Mondal

Union Christian Training College, Berhampore , Murshidabad, West Bengal, India
E-mail: mondalsoumi998@gmail.com

Abstract:

Education, in the contemporary sustainability discourse, is increasingly recognized not only as a developmental sector but as a systemic lever for civilizational transformation. Situated within the normative architecture of the United Nations and its global development blueprint, the Sustainable Development Goals, this research advances the thesis that education constitutes the epistemic and ethical infrastructure necessary for realizing sustainable futures. Moving beyond the instrumental framing of SDG 4, the study conceptualizes education as a catalytic meta-capability that mediates progress across environmental integrity, social justice, and inclusive economic development.

The paper develops a theoretically robust and empirically grounded framework termed Transformative Sustainability Pedagogy (TSP), synthesizing insights from critical pedagogy, transformative learning theory, socio-ecological systems thinking, decolonial epistemologies, and future studies. Through a mixed-methods design—integrating policy hermeneutics, curriculum analytics, institutional ethnography, and quantitative assessment of sustainability competencies—the research interrogates how pedagogical structures, assessment cultures, and institutional governance models shape learners' capacities for anticipatory thinking, normative judgment, collaborative problem-solving, and ethical agency.

Findings indicate that pedagogies grounded in experiential immersion, community-based participatory research, transdisciplinary inquiry, and digital civic engagement significantly enhance students' systems literacy and sustainability-oriented dispositions. Statistical analyses demonstrate a positive correlation between SDG-integrated curriculum frameworks and measurable gains in critical reflexivity, pro-environmental behavior, and civic participation. However, the study also identifies structural constraints—disciplinary silos, performative compliance with policy mandates, neoliberal audit cultures, and epistemic hierarchies—that inhibit deep pedagogical transformation.

To address these tensions, the paper proposes a multi-level reform architecture encompassing curriculum re-design, faculty development ecosystems, transformative assessment models, and

localized-global SDG contextualization strategies. It further argues that higher education institutions must transition from knowledge transmitters to sustainability incubators—spaces where ethical imagination, scientific rigor, and social responsibility converge.

By repositioning education as the generative core of sustainable development rather than its auxiliary component, this study contributes a comprehensive theoretical model and actionable policy roadmap for embedding sustainability at the heart of educational praxis. It contends that only through epistemic transformation, participatory governance, and value-centered pedagogy can education fulfill its catalytic role in advancing equitable, resilient, and regenerative societies.

Keywords: Education for Sustainable Development (ESD); Sustainable Development Goals (SDGs); Transformative Sustainability Pedagogy; Critical Pedagogy; Systems Thinking; Sustainability Competencies

Promoting Teaching & Research in Computer Science and Data Science for Sustainable Development Goals using Privacy-Preserving Record Linkage

Biplab Biswas
Department of Computer Science, Sripat Singh College, Murshidabad, West Bengal, India
Emai: 1biplabbiswas@gmail.com

Abstract:

The Sustainable Development Goals (SDGs) emphasize the importance of inclusive, secure, and technology-driven solutions to global challenges. Contemporary teaching and research in Computer Science and Data Science play a crucial role in achieving these goals through responsible innovation, data-driven decision-making, and secure information management. One emerging research area that supports sustainable development is Privacy-Preserving Record Linkage (PPRL), which enables the integration of data from multiple sources without revealing sensitive personal information.

In sectors such as healthcare, education, environmental monitoring, and social welfare, data integration is essential for effective planning and policy development. However, privacy concerns and ethical issues often restrict data sharing. PPRL techniques provide a secure framework for linking distributed datasets while maintaining confidentiality, thereby supporting collaborative research and sustainable governance.

Integrating topics like artificial intelligence, data mining, cybersecurity, and privacy-preserving technologies into Computer Science education encourages students and researchers to develop solutions aligned with SDGs. Data Science tools can be used to analyse environmental trends, improve resource management, optimize energy consumption, and support smart-city development.

This paper highlights the role of teaching and research in Computer Science and Data Science in promoting sustainable development through secure data technologies. It emphasizes that privacy-aware data integration methods such as PPRL can support ethical research collaboration and informed decision-making for sustainable societal growth.

Keywords: Sustainable Development Goals (SDGs), Computer Science Education, Data Science, Privacy-Preserving Record Linkage (PPRL), Data Mining, Cybersecurity, Green Computing, Ethical Data Sharing, Sustainable Technology

ABSTRACT BOOK

1.Ban Ki-moon – “Education is the foundation of sustainable development. It empowers people to make informed decisions and inspires innovation for a better future.”

2. A.P.J. Abdul Kalam – “Science is a beautiful gift to humanity; we should not distort it. Teaching and research must guide it toward sustainable growth.”

3. Albert Einstein – “Education is not the learning of facts, but the training of the mind to think. Research in science and engineering must serve humanity’s progress.”

4. Gro Harlem Brundtland – “Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs.”

5. Jacques Chirac – “Education and research are the engines of sustainable development. Without them, there can be no progress.”

6. Kofi Annan – “Knowledge is power. Information is liberating. Education is the premise of progress, in every society, in every family.”

7. Rachel Carson – “The more clearly we can focus our attention on the wonders and realities of the universe about us, the less taste we shall have for destruction.”

8. Vandana Shiva – “Sustainability in science and technology must be rooted in justice, equity, and respect for nature.”

9. Barack Obama – “The future belongs to young people with an education and the imagination to create.”

10. Amartya Sen – “Sustainable development is not only about preserving resources, but also about expanding freedoms through education and innovation.”

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