WORLD CONGRESS ON NANOMEDICINE 2026

Nanomedicine, where the future of Healthcare begins at the Nanoscale

27th - 29th September, 2026 | Vigyan Bhawan, New Delhi, India

- Organized by -

Institute of Nano Medical Sciences (INMS)

Faculty of Medical Sciences, University of Delhi, Delhi - 110007

Abstract Book

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राष्ट्रपति
भारत गणतंत्र
PRESIDENT
REPUBLIC OF INDIA



MESSAGE

I am happy to know that the Institute of Nano Medical Sciences (NIMS), University of Delhi is organising the World Congress on Nanomedicine 2026 from 27 to 30 September 2026.

Nanomedicine is an emerging field with huge potential to transform healthcare. Advancement in this field has enabled early diagnosis, targeted treatment, personalised care and better disease prevention leading to improved healthcare outcomes. It is important that the benefits of scientific research and innovation reach society and contribute to improving the lives of citizens. I am confident that this World Congress will provide an apt platform for experts from India and abroad to share knowledge, promote creativity and foster collaboration in the field of nanomedicine.

On this occasion, I extend my warm greetings and felicitations to the organisers and the participants and wish the event every success.

(Droupadi Murmu)

22 September 2026

सत्यमेव जयते

भारत के उपराष्ट्रपति
VICE-PRESIDENT OF INDIA



MESSAGE

I am pleased to know that the Institute of Nano Medical Sciences (INMS), University of Delhi, is organising the "*World Congress on Nanomedicine 2026*" from 27 to 30 September 2026 in New Delhi, which will be chaired by Nobel Laureate, Prof. Roger D. Kornberg.

Since its inception, the INMS has been a pioneering centre for nanomedicine, bringing together medical researchers, engineers and clinicians to advance research and innovation in healthcare through nanotechnology, robotics, artificial intelligence and data-driven approaches. As we move forward towards the vision of *Viksit Bharat @ 2047*, strengthening scientific research, innovation and indigenous technological capabilities is essential for building a knowledge-driven and self-reliant Nation. This Congress provides a valuable platform for eminent scientists, researchers, young scholars, industry leaders and institutions from India and across the world to exchange knowledge, share innovations and explore new possibilities in this rapidly advancing field.

I extend my best wishes to the organisers, distinguished scientists, researchers, young scholars and all participants of the *"World Congress on Nanomedicine 2026"*. May the Congress be a resounding success and lead to meaningful collaborations and innovations for the benefit of humanity.

Always in the service of the Motherland!

(C. P. Radhakrishnan)

New Delhi
September 17, 2026

JNCASR

जवाहरलाल नेहरू उन्नत वैज्ञानिक अनुसंधान केंद्र | Jawaharlal Nehru Centre For Advanced Scientific Research

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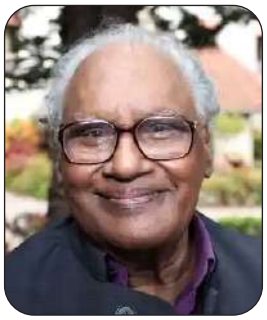
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विज्ञान एवं प्रौद्योगिकी विभाग,
भारत सरकार के अधीन
एक स्वायत्त संस्थान
मान विश्वविद्यालय संस्था

An Autonomous Institution
under Department of Science
and Technology, Govt. of India.

An Institution
Deemed-to- be-University

JNC/HPO/26-27
June 15, 2026



Message

I am pleased to learn that the Institute of Nano Medical Sciences (INMS), University of Delhi is organizing the World Congress on Nanomedicine during 27–30 September 2026 under the chairmanship of Prof. Roger D. Kornberg.

The Congress, bringing together eminent scientists and young researchers from across the world, will provide an important platform for the exchange of ideas and discussions on recent advances in nanomedicine. Such international and interdisciplinary meetings play an important role in the growth of science.

I extend my best wishes for the success of the World Congress on Nanomedicine 2026.

C.N.R. Rao, F.R.S.
Honorary President & Linus Pauling Research Professor
Jawaharlal Nehru Centre for Advanced Scientific Research
Jakkur P.O., Bangalore 560 064, India

डॉ. जितेन्द्र सिंह
राज्य मंत्री (स्वतंत्र प्रभार),
विज्ञान और प्रौद्योगिकी मंत्रालय,
पृथ्वी विज्ञान मंत्रालय,
राज्य मंत्री प्रधान मंत्री कार्यालय,
कार्मिक, लोक शिकायत तथा पेंशन मंत्रालय,
परमाणु उर्जा विभाग तथा अंतरिक्ष विभाग,
भारत सरकार

सत्यमेव जयते

DR. JITENDRA SINGH
Minister of State (Independent Charge),
Ministry of Science & Technology,
Ministry of Earth Sciences,
Minister of State, Prime Minister's Office,
Ministry of Personnel, Public Grievances and Pensions,
Department of Atomic Energy & Department of Space,
Government of India



Message

I am pleased to learn that the Institute of Nano Medical Sciences (INMS), University of Delhi plans to bring out a Souvenir in connection with the World Congress on Nanomedicine 2026 (WCN 2026) to be held under the chairmanship of Prof. Roger D. Kornberg, Nobel Laureate September, 2026 at Vigyan Bhawan, New Delhi.

This conference, I am told, revolves around developing "in-body hospital" during the next decade and to play a pioneering role in the development of nanomedicine to solve global human health problems The concept of an "in-body hospital" is a moonshot, a vision that might spark a wave of nanomedicine advancements.

The creation of nanomachines spread throughout the human body, can perform detection, diagnosis, and treatment while communicating wirelessly with doctors who monitor and direct treatment. To minimize the cost of health care, innovation is required to extend working lives and increase well-being through a multitude of new technologies and sectors that will stimulate economic growth.

I hope, the WCN 2026 core visions will include human health, quality of life with active sustainability, and seek to create both economic development and solutions to existing social problems.

This conference is a commendable effort to connect with leading experts from around the world, exchange ideas, discuss current developments and create potential collaborations.

I convey my greetings to everyone behind this endeavor and wish the World Congress success.

(Dr. Jitendra Singh)
MBBS (Stanley, Chennai)
MD Medicine, Fellowship Diabetes (AIIMS, New Delhi)
MNAMS Diabetes & Endocrinology
FICP (Fellow, Indian College of Physicians)

नायब सिंह
NAYAB SINGH

सत्यमेव जयते

मुख्य मन्त्री, हरियाणा,
चण्डीगढ़।

CHIEF MINISTER, HARYANA,
CHANDIGARH

Dated 21-07-2026



Message

It gives me immense pleasure to extend my warm greetings to the organizers, delegates, scientists, researchers, healthcare professionals, and students participating in the World Congress on Nanomedicine 2026.

Nanomedicine represents one of the most promising frontiers of modern science, with the potential to transform healthcare through precision diagnostics, targeted therapies, regenerative medicine and advanced biomedical technologies. By bringing together distinguished Nobel Laureates, renowned scientists, innovators and young researchers from across the globe, this prestigious congress will serve as a vibrant platform for the exchange of ideas, collaboration and scientific excellence.

Haryana is committed to promoting research, innovation and quality healthcare through a robust ecosystem that encourages scientific inquiry, technological advancement and skill development. We firmly believe that investment in science and innovation is essential for achieving sustainable development and improving the quality of life of our citizens.

I congratulate the Institute of Nano Medical Sciences (INMS), University of Delhi, the International Society of Nano Medical Sciences (ISNS) and all partner institutions for organizing this important global event. I am confident that the deliberations and outcomes of the Congress will contribute significantly to advancing nanomedicine and fostering international scientific cooperation.

I extend my best wishes for the grand success of the World Congress on Nanomedicine 2026 and hope that the event inspires new ideas, meaningful collaborations and groundbreaking innovations that will shape the future of healthcare.

(Nayab Singh)

CHIEF MINISTER
Jammu & Kashmir



Message

I am happy to know that the Institute of Nano Medical Sciences (INMS), University of Delhi is bringing out a Souvenir in connection with the World Congress on Nanomedicine 2026 (WCN 2026) to be held under the chairmanship of Prof. Roger D. Kornberg, Nobel Laureate during 27th to 30th September, 2026 at Vigyan Bhawan, New Delhi.

This conference revolves around developing "in-body hospital" during the next decade and to play a pioneering role in the development of nanomedicine to solve global human health problems. This conference envisages that in the future, we will have mini hospitals inside our bodies, complete with medical and diagnostic tools that operate as nanomachines.

The concept of an "in-body hospital" is a moonshot, a vision that might spark a wave of nanomedicine advancements. The creation of nanomachines that are spread throughout the human body and perform detection, diagnosis, and treatment while communicating wirelessly with doctors who monitor and direct treatment. The fundamental goal of the WCN 2026 is to create a hub of open innovation networks for smart health by bringing together medical researchers, engineers, and clinicians from Indian and international universities, government institutes, companies, and chemical manufacturing industries. To minimize the cost of health care, innovation is required to extend working lives and increase well-being through a multitude of new technologies and sectors that will stimulate economic growth. WCN 2026 core visions include human health, quality of life with active sustainability, and to create both economic development and solutions to existing social problems.

WCN 2026 is being organized to bring together all parties working in scientific, social, ethical and legal fields related to nanomedical sciences. This conference has received worldwide attention and audience where leading experts from around the world are looking forward to present their latest scientific work, along with exchanging ideas, discuss current developments and create potential collaborations.

I extend my heartfelt greeting and best wishes for the successful conduct of the significant event.

(Omar Abdullah)

Place: Srinagar
Dated: 25 June,2026.

V.D.SATHEESAN

CHIEF MINISTER

KERALAM



19.09.2026

MESSAGE

I am happy to learn that the Institute of Nano Medical Sciences (INMS), University of Delhi, is organising the "World Congress on Nanomedicine 2026" in New Delhi from 27 to 29 September 2026, under the chairmanship of Prof. Roger D. Kornberg, Nobel Laureate.

Nanomedicine is one of the most promising frontiers of modern science, with immense potential to transform diagnostics, drug delivery, and treatment methodologies across a wide range of diseases.

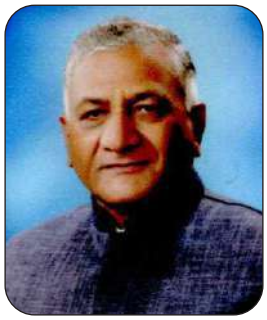
This congress, organised under the aegis of the International Society of Nano Medical Sciences (ISNS) and the International Society for Nanomedicine (ISNM), brings together over two thousand participants, including eminent scientists and young researchers from across the world, marking a significant step forward in this important field of research.

I extend my warm greetings and best wishes to the organisers, delegates and all participants of the World Congress on Nanomedicine 2026, and wish the event and the souvenir every success.

V. D. SATHEESAN

General (Dr) Vijay Kumar Singh
PVSM, AVSM, YSM (Retd)
GOVERNOR OF MIZORAM

LOK BHAVAN
Aizawl, Mizoram - 796001



Message

I am pleased to know that the Institute of Nano Medical Sciences (INMS), University of Delhi intends to bring out a Souvenir in connection with the World Congress on Nanomedicine 2026 (WCN 2026) to be held under the chairmanship of Prof. Roger D. Komberg, Nobel Laureate from 27th to 30th September, 2026 at Vigyan Bhawan, New Delhi. from

This conference revolves around developing "in-body hospital" during the next decade and to play a pioneering role in the development of nanomedicine to solve global human health problems. This conference envisages that in the future, we will have mini hospitals inside our bodies, complete with medical and diagnostic tools that operate as nanomachines.

The concept of an "in-body hospital" is a moonshot, a vision that might spark a wave of nanomedicine advancements. The creation of nanomachines that are spread throughout the human body and perform detection, diagnosis, and treatment while communicating wirelessly with doctors who monitor and direct treatment. The fundamental goal of the WCN 2026 is to create a hub of open innovation networks for smart health by bringing together medical researchers, engineers, and clinicians from Indian and international universities, government institutes, companies, and chemical manufacturing industries. To minimize the cost of health care, innovation is required to extend working lives and increase well-being through a multitude of new technologies and sectors that will stimulate economic growth. WCN 2026 core visions include human health, quality of life with active sustainability, and to create both economic development and solutions to existing social problems, which are very laudable.

WCN 2026 is being organized to bring together all working in scientific, social, ethical and legal fields related to nanomedical sciences. This conference has received worldwide attention and audience, where leading experts, from around the world are looking forward to present their latest scientific work, along with exchanging ideas, discuss current developments and create potential collaborations.

I convey my greetings to everyone behind this endeavor and wish the World congress success.

General (Dr) Vijay Kumar Singh

Date: 07th September, 2026

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नन्द किशोर यादव
राज्यपाल, नागालैंड
Nand Kishore Yadav
Governor of Nagaland

सत्यमेव जयते

लोक भवन
कोहिमा-797001
Lok Bhavan
Kohima-797001

September 01, 2026



Message

I am delighted to learn that the Institute of Nano Medical Sciences (INMS), University of Delhi, is publishing a Souvenir to mark the World Congress on Nanomedicine 2026 (WCN 2026), held under the chairmanship of Nobel Laureate Prof. Roger D. Kornberg from 27th to 30th September 2026 at Vigyan Bhawan, New Delhi.

Nanomedicine represents a transformative frontier in modern healthcare. The ambitious vision of developing targeted nanomachines and interactive healthcare solutions holds tremendous promise for global well-being, precision diagnostics, and affordable treatments. Bringing together leading global scientists, researchers, clinicians, and industry experts onto a single platform will undoubtedly spur innovative collaborations and drive sustainable scientific progress.

I extend my warm greetings and compliments to the organizing committee and all the distinguished participants. I wish the World Congress on Nanomedicine 2026 a resounding success.

(Nand Kishore Yadav)

CHANDRASHEKHAR H. VIJAYASHANKAR
Governor

सत्यमेव जयते

LOK BHAVAN
SHILLONG - 793001
MEGHALAYA
INDIA



Message

I am pleased to know that the Institute of Nano Medical Sciences (INMS), University of Delhi intends to bring out a Souvenir on the occasion of the World Congress on Nanomedicine 2026 (WCN 2026) to be held under the chairmanship of Prof. Roger D. Kornberg, *Nobel Laureate* during 27th to 29th September 2026 at Vigyan Bhawan, New Delhi.

The World Congress on Nanomedicine 2026 is envisaged as a significant international scientific forum bringing together eminent scientists, academicians, researchers, medical professionals, industry leaders, policymakers, and young researchers from across the world to deliberate upon the latest developments and emerging opportunities in the field of nanomedicine. The Congress will provide a valuable platform for meaningful academic and scientific exchange in areas such as nanotechnology-enabled healthcare, targeted drug delivery, diagnostics, nanotherapeutics, biomaterials, cancer nanomedicine, regenerative medicine, and other emerging applications of nanoscience in medicine and healthcare.

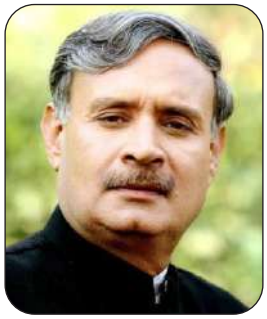
I convey my greetings to everyone behind this endeavor and wish the World congress success.

(C.H. Vijayashankar)

राव इन्द्रजीत सिंह
RAO INDERJIT SINGH

सत्यमेव जयते

राज्य मंत्री (स्वतंत्र प्रभार)
सांख्यिकी और कार्यक्रम कार्यान्वयन मंत्रालय;
राज्य मंत्री (स्वतंत्र प्रभार) योजना मंत्रालय तथा
राज्य मंत्री संस्कृति मंत्रालय
भारत सरकार
Minister of State (Independent Charge) of the
Ministry of Statistics and Programme Implementation;
MOS (I/C) of the Ministry of Planning and
MOS in the Ministry of Culture
Government of India



Message

I am pleased to know that the Institute of Nano Medical Sciences (INMS), University of Delhi, intends to bring out a Souvenir in connection with the World Congress on Nanomedicine 2026 (WCN 2026), to be held under the chairmanship of Prof. Roger D. Kornberg, Nobel Laureate, from 27th to 30th September 2026 at Vigyan Bhawan, New Delhi.

This conference revolves around developing an "in-body hospital" during the next decade and playing a pioneering role in the development of nanomedicine to solve global human health problems. It envisages that in the future, we will have mini hospitals inside our bodies, complete with medical and diagnostic tools that operate as nanomachines, communicating wirelessly with doctors who monitor and direct treatment.

The concept of an "in-body hospital" is a moonshot, a vision that might spark a wave of nanomedicine advancements. For a country of our size and diversity, the promise of nanomedicine lies in ease of access. Diagnosis that is early, accurate and inexpensive, and treatment that reaches the citizen in the smallest district hospital as surely as it does in a metropolis, would transform the delivery of health care in India. I would, therefore, urge the scientific community gathered here to keep affordability and achieve the targets, so that the benefits of these advancements are reached to the masses.

I convey my greetings to everyone associated with this endeavour, and to the scientists, young researchers and delegates from within the country and abroad, and wish the World Congress on Nanomedicine 2026 a grand success.

(Inderjit Singh)

New Delhi
17 September, 2026

जी. किशन रेड्डी
జి. కిషన్ రెడ్డి
G. Kishan Reddy

कोयला एवं खान मंत्री
भारत सरकार
नई दिल्ली
MINISTER OF COAL AND MINES
GOVERNMENT OF INDIA
NEW DELHI

D.O. No. 73 /M(C&M)/VIP/2026 Dated: 22 September, 2026



Message

Dear Prof. Ramesh Chandra ji, Namaskar,

I greatly acknowledge your kind invitation to grace the **World Congress on Nanomedicine 2026**. I deeply appreciate your thoughtful gesture and the significance of this platform.

It is highly commendable that the Institute of Nano Medical Sciences (INMS), University of Delhi, is organizing this prestigious congress to bring together scientists, researchers, and global experts to deliberate on cutting-edge innovations and advancements in nanomedicine.

Due to prior official commitments, I regret my inability to attend the event. I convey my best wishes for the grand success of the conference.

With warm regards,

Regards,

Yours sincerely,

(G. Kishan Reddy)

Prof. Ramesh Chandra
Institute of Nano Medical Sciences (INMS),
Faculty of Medical Sciences
University of Delhi, Delhi – 110007

दिल्ली विश्वविद्यालय
University of Delhi

प्रो॰ योगेश सिंह
कुलपति

Prof. Yogesh Singh
Vice-Chancellor

No. DU/VC/2026/789
25th September 2026

MESSAGE



It gives me immense pleasure to know that Institute of Nano Medical Sciences (INMS), a Centre established by the University of Delhi is bringing out a Souvenir on the historic occasion of the World Congress on Nanomedicine (WCN 2026) which is scheduled to be held with effect from September 27 to September 30, 2026 at the Vigyan Bhawan in the Capital of Bharat, Delhi.

It is a matter of immense pride for the University of Delhi fraternity as this University, a Century Old Institution of Eminence, has always espoused the idea of exponential academic progression through quality teaching learning, encouragement of cutting edge research and creation of new knowledge as a natural outcome of such ever evolving academic endeavours. Establishment of the Institute of Nanomedical Sciences (INMS) is a natural outcome of this legacy.

As our Nation progress towards the path of Viksit Bharat by the year of 2047 as envisioned by our Hon'ble Prime Minister, strengthening scientific research, innovation and indigenous technological capabilities is essential for building a knowledge-driven and self-reliant Nation. In this context, WCN 2026 represents an important platform for advancing nanomedicine and fostering collaboration among distinguished scientists, researchers, clinicians, engineers, industry leaders and other stakeholders. The core vision of WCN 2026 encapsulates human health, quality of life with active sustainability while paving the way for overall social and economic development.

This World Congress on nanomedicine has received worldwide attention where leading experts from around the world are looking forward to present their latest scientific achievements alongwith exchange of ideas, discussion on contemporary developments and creation of potential collaborations.

Let me take this opportunity to convey warm greetings and best wishes to all the distinguished participants from across the Globe including our Nation and the organising team for successful organization of World Congress on Nanomedicine 2026 which, I am sure, will remain etched in the memory of everyone forever.

Yogesh Singh
25/9/26

दिल्ली विश्वविद्यालय, उत्तरी परिसर, दिल्ली - ११०००७, भारत
University of Delhi, North Campus, Delhi-110007, India
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INSTITUTE OF NANO MEDICAL SCIENCES (INMS)
Faculty of Medical Sciences
University of Delhi, Delhi-110 007, INDIA

Message from the Founder Director, INMS



Humanity has always progressed by daring to explore the unknown. From reaching the Moon to preparing for missions beyond it, science has continually transformed what once seemed impossible into reality. Yet, while we explore the vastness of space beyond us, an equally remarkable frontier remains within us - the human body, it is this frontier that the World Congress on Nanomedicine 2026 (WCN 2026) seeks to explore. WCN 2026 is jointly organized by International Society of Nanomedical Sciences (ISNS), International Society for Nanomedicine (ISNM) and Institute of Nano Medicine Sciences (INMS), under the Chairmanship of Prof. Roger D. Kornberg, *Nobel Laureate*. This congress will bring together the global scientific community to advance the frontiers of nanomedicine. I envision the ultimate aspiration of nanomedicine as an "In-Body Hospital"- a future in which intelligent nanoscale systems could travel within the human body to detect disease at its earliest stage, deliver treatment precisely where it is required, monitor biological changes and communicate vital information to healthcare professionals. If humanity can build machines capable of travelling to the Moon, we must also dare to build machines small enough to travel within us and powerful enough to protect human life. What may appear to be a moonshot today could become an important scientific direction for the medicine in future.

India must play an active role in shaping this future. The establishment of INMS at the University of Delhi reflects our conviction that India can contribute significantly to this emerging frontier by bringing together nanotechnology, medicine, biology, engineering, artificial intelligence, robotics and advanced materials. The journey towards "In-Body Hospitals" will begin with advances in targeted drug delivery, nanoscale diagnostics, early cancer detection, precision nanotherapeutics, nanoimaging, regenerative medicine and disease monitoring. WCN 2026 was conceived not merely as a scientific conference, but as a platform for convergence, bringing together scientists, clinicians, engineers, innovators, industry leaders and young researchers from India and across the world to exchange ideas, foster collaborations and translate discoveries into meaningful healthcare solutions. The larger vision of INMS is to create an open innovation ecosystem for smart health, where fundamental science, technology and clinical needs come together to develop healthcare that is more precise, preventive, affordable and accessible.

As emphasized by Hon'ble Prime Minister Shri Narendra Modi at the BRICS Summit 2026, technology must serve humanity through responsible and inclusive innovation. Humanity once looked beyond Earth to reach the Moon; today, nanomedicine challenges us to look within ourselves and transform the future of healthcare. I warmly welcome all distinguished academicians, clinicians, industry leaders, young researchers and innovators to WCN 2026 and invite them to join us in turning this vision into a scientific reality for the benefit of humankind.

I wish the World Congress on Nanomedicine 2026 every success and hope that this conglomeration of intelligent minds will inspire transformative discoveries, foster meaningful collaborations and advance the frontiers of nanomedicine, ultimately improving human health, enhancing quality of life and contributing to the well-being of humankind and generations to come.

Prof. Ramesh Chandra, *FAMS, FRSC*
Founder Director, INMS
President, WCN 2026

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Webpage: www.wcn2026.in; www.inms.du.ac.in; Email: office@inms.du.ac.in; director@inms.du.ac.in
Phone: +91-11-27662930 (Lab), +91-11-27667151, 27666245 (Office)

Message from the Director



It is a matter of immense pride and privilege for the Institute of Nano Medical Sciences (INMS), University of Delhi, to welcome Nobel Laureates, distinguished scientists, clinicians, academicians, innovators and young researchers from across the world to the World Congress on Nanomedicine 2026 (WCN-2026), being held from 27–29 September 2026 under the distinguished chairmanship of Prof. Roger D. Kornberg, Nobel Laureate.

Established by the University of Delhi during its Centenary Year (2022), INMS embodies the University's commitment to pioneering interdisciplinary science and translating scientific discoveries into meaningful advances in human health.

Nanomedicine stands at a remarkable frontier where the fundamental sciences, engineering and clinical medicine converge. INMS seeks to create an ecosystem that nurtures this convergence through cutting-edge research, advanced education, training and biomedical innovation, in keeping with the vision of National Education Policy 2020.
WCN 2026 brings together the global nanomedicine community to exchange ideas, showcase transformative discoveries and forge new collaborations. Its scientific programme encompasses targeted drug delivery, nanoparticle-based diagnostics, cancer and regenerative nanomedicine, precision nanomedicine, artificial intelligence, nanobiosensors and advanced medical devices.

The true legacy of a scientific gathering lies not only in the knowledge exchanged, but in the questions it inspires, the collaborations it creates and the possibilities it unlocks. May WCN 2026 become a landmark forum where disciplines converge, young minds are inspired and scientific excellence is translated into innovations that serve humanity.
I extend my warmest welcome to all participants and seek everyone's enthusiastic participation towards making WCN-2026 a memorable and resounding success.

Prof. Indrajit Roy
Director
Institute of Nano Medical Sciences
Faculty of science
University of Delhi
Delhi-110007, India

INSTITUTE OF NANO MEDICAL SCIENCES (INMS)
Faculty of Medical Sciences
University of Delhi, Delhi-110 007, INDIA

Message



Nanomedicine is no longer confined to the realm of possibility; it is emerging as a powerful bridge between fundamental science and the future of healthcare. By engineering matter at the nanoscale, we are learning to approach disease with greater precision- delivering therapeutics more selectively, enabling earlier diagnosis, reducing unwanted effects and opening new possibilities for personalized treatment. At the Institute of Nano Medical Sciences (INMS), University of Delhi, our vision is to advance this convergence of science and medicine through interdisciplinary research that connects nanotechnology with drug and gene delivery, diagnostics, biomedical devices, cancer biology, neuroscience, infectious diseases, regenerative medicine and other emerging areas. Our emphasis is not only on discovery, but on translation- turning innovative ideas generated in the laboratory into technologies that can ultimately make healthcare more effective, affordable and accessible. This requires bringing together diverse scientific perspectives, challenging conventional boundaries and creating an environment where curiosity can evolve into innovation and meaningful scientific solutions.

The World Congress on Nanomedicine 2026 (WCN 2026) is a celebration of this convergence. It brings together leading academicians, scientists, clinicians, engineers, industry leaders, innovators and young researchers from across the world, creating a shared space where ideas can intersect, disciplines can connect and new collaborations can begin. The true strength of a scientific congress lies not only in the discoveries presented, but in the questions they generate, the partnerships they inspire and the possibilities they create for the future. WCN 2026 seeks to provide precisely such an environment- one that encourages bold thinking, meaningful dialogue and collaborative problem-solving. As we look towards the next generation of nanomedicine, I believe that the most transformative breakthroughs will emerge where disciplines meet and where scientific imagination is matched by a commitment to human welfare.

We warmly welcome all participants to WCN 2026 and hope that this confluence of knowledge, talent and ideas will inspire new discoveries, strengthen global partnerships and help shape a healthier future for society and humankind.

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Plenary Speakers



Prof. G. P. Talwar, *FNA*

Founder Director,
Talwar Research Foundation, New Delhi, India

Prof. G. P. Talwar, FNA

Founder Director, Talwar Research Foundation, New Delhi, India

Prof. Gursaran Prashad Talwar is a distinguished Indian biomedical scientist and a pioneer in immunology, reproductive biology, vaccine research, and biomedical sciences. He is the Founder Director of the Talwar Research Foundation, New Delhi, and was the Founder Director of the National Institute of Immunology (NII), New Delhi. He also served as Professor and Head of the Department of Biochemistry at the All India Institute of Medical Sciences (AIIMS), New Delhi, from 1965 to 1983.

Prof. Talwar received his Docteur ès Sciences from the Sorbonne University, Paris, and has been elected Fellow of several prestigious national and international academies, including the Indian National Science Academy (FNA), Indian Academy of Sciences, National Academy of Medical Sciences, and the World Academy of Art and Science.

His pioneering research has made significant contributions to immunology, reproductive health, vaccine development, and infectious diseases. He is particularly recognized for his work on Mycobacterium indicus pranii (MIP) and its development as a vaccine-based approach in leprosy research. His research has also explored innovative approaches to immunocontraception and therapeutic vaccines.

Prof. Talwar has held several distinguished academic and research positions, including Jawaharlal Nehru Fellow, Scholar-in-Residence at the National Institutes of Health, Bethesda, Wellcome Professor at Johns Hopkins University, and Professor of Eminence at the International Centre for Genetic Engineering and Biotechnology (ICGEB).

His exceptional contributions have been recognized with numerous national and international honors, including the Padma Bhushan, National Award in Bio-Medicine, Basanti Devi Amirchand Prize, J. C. Bose Award in Life Sciences, FICCI Award, and several other prestigious scientific distinctions.

Through decades of pioneering research and institution building, Prof. Talwar has made enduring contributions to Indian biomedical science and continues to inspire advances in immunology, vaccines, reproductive health, and translational biomedical research.

End to End mission oriented research

Prof. G. P. Talwar, *FNA*

Founder Director,
Talwar Research Foundation, New Delhi, India

Abstract



Prof. R. A. Mashelkar, *FRS*

Jio Institute (Chancellor);
President, Global Research Alliance

Prof. Raghunath Anant Mashelkar is an internationally acclaimed scientist, chemical engineer, research leader, and innovation thought leader, renowned for his pioneering contributions to polymer science and engineering, inclusive innovation, intellectual property, and science and technology policy. He is Chancellor of Jio Institute and President of the Global Research Alliance.

Prof. Mashelkar obtained his Bachelor's degree in Chemical Engineering in 1966 and Ph.D. in Chemical Engineering from the University of Bombay in 1969. He subsequently held academic and research positions in the United Kingdom and the United States before joining the National Chemical Laboratory (NCL), Pune, where he served as Director from 1989 to 1995. He later served as Director General of the Council of Scientific and Industrial Research (CSIR), Government of India, from 1995 to 2006, providing transformative leadership to one of the world's largest publicly funded R&D networks.

His research in polymer science and engineering has earned international recognition, while his broader contributions have influenced India's innovation ecosystem, intellectual-property framework, and science and technology policies. He has also championed the concept of "Gandhian Engineering" and the philosophy of achieving more from less for more people, promoting affordable and inclusive innovation.

Prof. Mashelkar is a Fellow of the Royal Society (FRS), UK, and has been elected to several leading international academies, including the U.S. National Academy of Sciences, U.S. National Academy of Engineering, Royal Academy of Engineering, and American Academy of Arts and Sciences. He has received numerous prestigious honors, including the Padma Shri, Padma Bhushan, and Padma Vibhushan.

Through his scientific research, institutional leadership, and advocacy of innovation for societal benefit, Prof. Mashelkar continues to play an influential role in advancing research, technology, entrepreneurship, and inclusive innovation in India and globally.

From Nano-Scale Science to Humanity-Scale Impact: More from Less for More

Prof. R. A. Mashelkar, *FRS*

Former DG, CSIR & President, INSA

Abstract

"More from Less for More" is a universal framework for creating greater value from fewer resources and extending its benefits to all. Nanomedicine offers a powerful expression of this philosophy: more therapeutic efficacy from less drug, more diagnostic information from less sample, and more precision with less toxicity, cost and waste. Its ultimate promise, however, lies not merely in scientific miniaturisation, but in democratising advanced healthcare through affordable, scalable and sustainable innovation. This lecture calls for a new paradigm of ASSURED and access-by-design nanomedicine—moving from personalised medicine to mass-personalised medicine, and from nano-scale science to humanity-scale impact.



Prof. Roger D. Kornberg

Nobel Laureate

Stanford University, USA

(Chairman, WCN-2026)

Prof. Roger D. Kornberg, Ph.D.

Nobel Laureate | Stanford University, USA | Chairman, WCN-2026

Prof. Roger D. Kornberg is a distinguished American biochemist and structural biologist whose pioneering research has transformed our understanding of how genetic information is expressed in living cells. He was awarded the 2006 Nobel Prize in Chemistry for his fundamental studies of the molecular basis of eukaryotic transcription, establishing in unprecedented structural detail how DNA is transcribed into RNA.

Prof. Kornberg received his undergraduate degree in Chemistry from Harvard University in 1967 and his Ph.D. in Chemistry from Stanford University in 1972. Following postdoctoral research at the Laboratory of Molecular Biology in Cambridge, UK, he joined Harvard Medical School before returning to Stanford in 1978. He is currently a Professor of Structural Biology and the Mrs. George A. Winzer Professor in Medicine at Stanford University School of Medicine.

One of Prof. Kornberg's most significant contributions was the structural elucidation of RNA polymerase II, the molecular machinery responsible for transcribing DNA into messenger RNA in eukaryotic cells. His work provided an atomic-level view of transcription and helped explain how genetic information encoded in DNA is selectively read and converted into RNA.

Earlier in his career, Prof. Kornberg made fundamental contributions to the understanding of chromatin and nucleosomes, proposing the nucleosome as the basic structural unit of eukaryotic chromosomes. His research has subsequently expanded to include transcriptional regulation, chromatin remodeling, Mediator complexes, and the molecular mechanisms governing gene expression.

Prof. Kornberg's continuing research at Stanford focuses on elucidating the molecular machinery of transcription and its regulation, including the structures and functional interactions of the components involved in gene expression. His discoveries have provided essential foundations for understanding normal cellular function as well as processes associated with human disease.

As Chairman of the World Congress on Nanomedicine 2026 (WCN-2026), Prof. Kornberg brings exceptional scientific leadership and a distinguished record of interdisciplinary research to the Congress, contributing to its vision of advancing innovative research at the interface of science, medicine, and technology.

Prof. Roger D. Kornberg

Nobel Laureate

Stanford University, USA

(Chairman, WCN-2026)

Abstract



Prof. Thomas M. S. Chang

Honorary President, ISNS
McGill University, Canada

Prof. Thomas M. S. Chang, O.C., M.D., Ph.D.

Honorary President, International Society for Nanomedical Sciences (ISNS) | McGill University, Canada

Prof. Thomas Ming Swi Chang is an internationally renowned physician, scientist, inventor, and pioneer in the fields of artificial cells, blood substitutes, nanomedicine, and biomedical engineering. He is Professor Emeritus of Physiology at McGill University and has served as Director of the Artificial Cells and Organs Research Centre at McGill.

Prof. Chang is widely recognized as the inventor of artificial cells. As an undergraduate student at McGill University in 1957, he conceived and developed the first artificial cells—an innovation that established a new field of biomedical research. His pioneering work demonstrated that semipermeable microcapsules could encapsulate biological materials and perform selected functions of natural cells.

His subsequent research led to important advances in artificial blood cells, blood substitutes, enzyme therapy, hemoperfusion, drug delivery, and artificial organs. His work on microencapsulation has enabled biological molecules, enzymes, hemoglobin, cells, and other therapeutic materials to be incorporated into artificial structures for potential medical applications.

Prof. Chang has made significant contributions to the development of artificial-cell-based approaches for conditions including renal failure, liver failure, metabolic disorders, drug poisoning, and enzyme deficiencies. His research has also contributed to the broader development of nanomedicine and biotherapeutics.

He has authored hundreds of scientific publications and numerous books and chapters, and has delivered extensive invited and plenary lectures internationally. Among his many honors, he was appointed an Officer of the Order of Canada and was recognized by McGill University as one of its "Greatest McGillians."

Prof. Chang currently serves as Honorary President of the International Society for Nanomedical Sciences (ISNS) and continues to contribute to the advancement of artificial cells, nanomedicine, and innovative biomedical technologies.

Prof. Thomas M. S. Chang

Honorary President, ISNS
McGill University, Canada

Abstract

Keynote Speakers



Prof. Alicia El Haj

FRSB, FREng, FIRM, FEAMBES

Healthcare Technology Institute, University of Birmingham, UK

Professor Alicia El Haj, FREng, FRSB, FEAMBES, FIRM, Interdisciplinary Chair in Cell Engineering and Director of the Institute of Translational Medicine at Birmingham University, UK. She is a leading figure in Bioengineering and Regenerative Medicine globally translating cross disciplinary innovative new cell based therapies to the clinic. She has multiple international collaborations with EU research exchange programmes in Europe, Asia, Australia and USA. She has published over 300 publications with funding from EPSRC, MRC, BBSRC, Versus Arthritis, EU Commission, Innovate and an ERC Advanced Award in 2018. She is Director and co Founder of a spin out company MICA Tx involved in translating remote magnetic nanotechnology platforms to the clinic.

She was awarded with a Royal Society Merit Award in 2014 and is a Fellow of the Royal Academy of Engineering in the UK. In 2015, she was awarded the MRC Suffrage Award for her role in leading women in STEM and in 2021 awarded the Midlands Women in Tech Award. In 2020/21, she was awarded the IOM3 Chapman medal for her major contribution towards translation of biomedical materials into healthcare and the TERMIS Career Achievement Award for discovery and translation of tissue engineering and regenerative medicine into the clinic. In 2022, her contributions to bioengineering field was recognized with an Honorary DSc from the University of Glasgow.

Remote nanomagnetic activation of mechanotransduction: principles, therapies, and translational challenges

Alicia El Haj

FRSB, FREng, FIRM, FEAMBES

Healthcare Technology Institute, University of Birmingham, UK

Abstract

Mechanical signalling is increasingly recognized as a therapeutic target for indications such as regenerative medicine and tissue engineering, orthopaedics, cancer, neurosciences and wound repair. Physical forces act alongside soluble factors and topographical cues to shape cell behaviour. Magnetic nanoparticles (MNP) and nanomedicine offers a novel approach for delivering physical cues in localised regions of the body remotely from outside the patient. MNPs are being used in nanomedicine for other indications such as imaging, magnetic hyperthermia, cell tracking and targeted delivery.

MNPs can also be actuated remotely, functionalized with biological ligands for different target indications, and incorporated onto and into cells, scaffolds, hydrogel based therapeutic platforms. Mechanoresponsive receptors on the cell membrane such as TREK1, TRPV4, PIEZO1, TCR and Frizzled/Wnt signalling have been screened as targets for MNP activation of downstream signalling pathways in multiple tissues. Designing novel MNPs and functionalising strategies for remote mechanotransduction is central to the future of this field. Magnetically driven mechanotransduction sets out to meet a challenge: can magnetic particles be used not only as carriers, labels or heating agents, but also as active interfaces for controlling cell signalling and fate? In my lab, we have been developing a platform called MICA or magnetic ion channel activation and are on route to the clinic currently for Orthopaedic applications but with clinical applications spanning cancer therapy, osteoarthritis and neurodegenerative disease.

In this presentation, I will review progress in this field and the work we have been undergoing aiming towards routine clinical use. A central theme is the evidence ladder needed to connect acute cell level signalling events with tissue-level outcomes and clinical efficacy. Key translational barriers include particle quality control, field dosimetry, biological specificity and standardisation. Addressing these limitations is an important step for translating magnetic activation of mechanotransduction from a sophisticated experimental modality into a clinically applicable technology.



Prof. Amit Kumar Dinda

Director Research, Amrita Vishwa Vidyapeetham,
Faridabad Campus

Dr. Amit K. Dinda is currently working as Director Research and Consultant at Amrita Vishwa Vidyapeetham Faridabad, leading the Amrita Research Center and integrating Amrita Institute of Medical Sciences and Amrita Hospital transforming it as a Translational Hub. He established Centre for Medical Innovation and Entrepreneurship (CMIE), a BioNest bioincubator at AIIMS Delhi. He was Professor of Pathology at the same institute served as ICMR Emeritus Scientist after superannuation. He did his MBBS from Calcutta Medical College, post-graduation in Pathology at AIIMS followed by PhD in the area of Neuro-oncology. His research area includes Immuno and experimental pathology, nanomedicine, regenerative medicine and regulatory science. He has published more than 450 articles in indexed journal, edited 4 books, written 14 chapters in books and filed 12 patents. He is President of Indian Society of Renal & Transplant Pathology and Founder Secretary of Indian Society of Nanomedicine. He worked as a Visiting Professor in Molecular Nephrology at Long Island Jews Medical Center & Albert Einstein Medical College, New York, USA and Dept. of Biomedical Engineering at University of New South Wales, Sydney, Australia honorary Professor Deakin University, Australia . He is a senior assessor for NABL, GLP and GCP quality systems and served as an executive member of Global Council of Regulatory.

Translational Nanomedicine: Current Status, Bench-to-Bedside Barriers, and Future Perspectives

Prof. Amit Kumar Dinda

Director Research, Amrita Vishwa Vidyapeetham, Faridabad Campus

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Abstract

Translational nanomedicine has emerged as a revolutionary paradigm in modern healthcare, offering unprecedented opportunities to enhance drug delivery, optimize therapeutic efficacy, and minimize systemic toxicities. By utilizing engineered nanomaterials such as liposomes, polymeric micelles, and inorganic nanoparticles, the field has successfully transitioned several platforms into clinical practice, most notably in oncological therapeutics and mRNA vaccine deployment. Despite these pioneering milestones, a significant discrepancy remains between preclinical success and widespread clinical approval. This abstract reviews the current clinical status of nanomedicines while critically analyzing the primary bottlenecks hindering their translational trajectory. Biological barriers, including unexpected immune clearance, complex patient-specific pathophysiology, and the inconsistent reproducibility of the enhanced permeability and retention (EPR) effect, pose severe physiological challenges. Furthermore, commercial development is heavily constrained by industrial limitations; the structural complexity of nanoformulations complicates chemistry, manufacturing, and control (CMC) scale-up, resulting in high production costs.

Comprehensive nanotoxicology remains difficult to standardize, creating a scientific gap that complicates navigating rigorous, unadapted government regulatory frameworks. Intellectual property ambiguities further stall market translation. To bridge this translational divide, the next generation of nanomedicine must shift from formula-driven designs toward disease-driven approaches. Accelerating clinical translation requires standardized characterization protocols, advanced predictive toxicology models, and robust interdisciplinary collaboration among researchers, clinicians, and regulatory bodies. Overcoming these multi-faceted challenges is imperative to fully unlock the potential of nanotechnology, ultimately paving the way for personalized, highly effective targeted interventions in global disease management.

Keywords: Translational nanomedicine, Drug delivery systems, Clinical translation, Nanotoxicology, Scale-up manufacturing, Regulatory approval



Prof. Eun Ha Choi

Plasma Bioscience Research Center, Kwangwoon University, Seoul, Kore

Prof. Eun Ha Choi is an internationally recognized scientist and a leading researcher in plasma bioscience, plasma medicine, and biomedical applications of nonthermal plasma. He is Professor in the Department of Electrical and Biological Physics at Kwangwoon University, Seoul, and serves as Director of the Plasma Bioscience Research Center (PBRC) and the Applied Plasma Medicine Center (APMC).

Prof. Choi received his B.S. in Physics from Seoul National University, followed by an M.S. and Ph.D. in Plasma Physics from KAIST. His research career has focused on the development and application of plasma technologies in biology and medicine.His research encompasses nonthermal atmospheric-pressure plasma, plasma–biological interactions, plasma-activated liquids, reactive oxygen and nitrogen species (RONS), plasma nanotechnology, and plasma-based therapeutic technologies. His work has contributed to understanding how plasma-generated reactive species interact with biological cells and tissues, creating opportunities for applications in medicine, healthcare, and biotechnology.A major focus of Prof. Choi's research is the development of plasma medicine technologies, including approaches for wound treatment, skin-related diseases, cancer research, microbial inactivation, and biomedical applications of plasma-activated materials. His research has also explored the use of atmospheric-pressure plasma systems and their interaction with biological environments for therapeutic and public-health applications.

Prof. Choi has contributed extensively to the scientific literature in plasma bioscience and has published more than 500 scientific papers, particularly in the fields of nonthermal plasma and plasma medicine. He has also played an important role in the standardization of atmospheric-pressure plasma medical devices, including international efforts related to plasma-based wound-treatment technologies.Through his interdisciplinary research integrating plasma physics, biology, medicine, nanotechnology, and engineering, Prof. Choi continues to advance the emerging field of plasma medicine and its potential applications in next-generation healthcare technologies.

Non-thermal Atmospheric Pressure Plasma Sources and Their Long-lived Nanobubbled Nitric Oxide (no) Water for Quantum Agriculture, Bioscience and Environment

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Abstract

Field test of plasma agriculture in Korea would be introduced and discussed for transfer from laboratory for strawberry, flowers, sweet potato, lettuce, radish [1], and many other commercial crops. For this project the multi-electrode cylindrical dielectric barrier discharged (MEC-DBD) plasma nitric oxide (NO) source and generator, PLAS-AG100, has been developed for the major and mass production of plasma NO water, from which plasma activated NO water could be produced for sterilization, growth and cultures [2] under low power consumption less than 300 W and maintaining pH with 6.5~7.3 for neutrality. Also the plasma characteristics of MEC-DBD plasma source as well as its NO water properties would also be described for plasma agriculture and smart farm. Especially the strawberry farm is now well operating at Non-San area, which is located by south region of 200 km from Seoul, by plasma NO water [3] for promotion of sugar content and volatile components with long freshness preserving periods. Recently plasma NO water system has been combined with the nanobubble generator for the enhancement of NO concentration and its lifetime in water for applications in agriculture, bioscience and medicines.

This environmental friendly technology can be used for synthesis of various nanoparticles and material sciences.



Figure 1. Plasma NO water generator with MEC DBD Plasma sources.

Keywords: plasma agriculture, multicylinder dielectric barrier plasma source, plasma NO water, smart fam, ordor reduction

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Prof. Gopal C. Kundu

School of Biotechnology, KIIT University,
Bhubaneswar 751024, India

Prof. Gopal Chandra Kundu is a distinguished biomedical scientist and academic leader serving as Director, Research & Development at KIIT University, Bhubaneswar. He has made significant contributions to the fields of cancer biology, molecular oncology, angiogenesis, stem cell biology and translational biomedical research. His research has focused particularly on understanding the molecular mechanisms underlying cancer progression, tumour angiogenesis and metastasis, with the broader goal of developing novel therapeutic strategies for cancer.Prof. Kundu has received several prestigious national and international honours in recognition of his outstanding contributions to biological and biomedical sciences. These include the Shanti Swarup Bhatnagar Prize in Biological Sciences, awarded by the Council of Scientific and Industrial Research (CSIR), Government of India, in 2004, and the National Bioscience Award for Career Development from the Department of Biotechnology (DBT), Government of India, in 2003–04.

His international recognitions include the Fellows Award for Research Excellence (FARE) from the National Institutes of Health (NIH), Bethesda, USA, in 1997; the International Award for Outstanding Achievement in Oncology, Greece, in 2007; and the International Young Investigator Award at the 5th Mayo Clinic Angiogenesis Symposium, USA, in 2012.Among his other notable distinctions are the Platinum Jubilee Award Lecture of the Indian Science Congress Association in 2012, the 7th National Grassroots Innovation Award, presented at Rashtrapati Bhavan, New Delhi, in 2013, and selection for the NASI Senior Scientist Platinum Jubilee Fellowship in 2020.

He was also selected for the Sir J. C. Bose National Fellowship by the Science and Engineering Research Board (SERB), Government of India, for the period 2024–2027.Through his extensive research, academic leadership and mentoring, Prof. Kundu continues to contribute to the advancement of cancer research, molecular medicine and translational biomedical sciences, while promoting interdisciplinary research and innovation in India.

Chitosan Nanoparticle-mediated RGD-targeted delivery of Raloxifene selectively suppresses Tumor Growth and Angiogenesis in Breast Cancer

Gopal C. Kundu, Srijita Jana and Amit S. Yadav

School of Biotechnology, KIIT University, Bhubaneswar 751024, India
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Abstract

Cancer is a complex disease, and most cancer treatments are limited to chemotherapy, radiation, and surgery. Substantial advances in cancer treatments have resulted in significant decrease in mortality. However, existing cancer therapies often result in drug resistance and nonspecific side effects. Therefore, better targeted delivery and increased efficacy of drugs are crucial to overcome these effects. Application of nanotechnology or nanoparticle-mediated drug delivery can resolve some of these issues. In this study, we investigated the direct effect of pH in synergy with RGD peptide-based targeting on the therapeutic efficacy of chitosan nanoparticles (RGD-CHNPs) in breast cancer. Moreover, we performed a comprehensive study showing the anti-tumor and anti-angiogenic effect of raloxifene (Rlx) loaded CHNPs in breast cancer. Accordingly, stable formulations of raloxifene encapsulated CHNPs and RGD-CHNPs were prepared. The pH dependent studies revealed that NPs possess higher stability and zeta potential along with enhanced cellular uptake at the acidic pH. Furthermore, RGD conjugation enhanced the in vitro cellular uptake of CHNPs in αvβ3 integrin expressing breast cancer cells and induced higher cellular apoptosis in these cells which was further augmented by lower pH. Moreover, Rlx-RGD-CHNPs significantly inhibited breast cancer cell migration and angiogenesis. In vivo studies showed that Cy5.5 conjugated RGD-CHNPs distinctly visualizes the tumors and Rlx-RGD-CHNPs significantly regresses the breast tumor growth without causing any toxic effect to normal tissue as confirmed by hematological and biochemical studies. Thus, RGD-CHNPs could potentially enhance the therapeutic efficacy of chemotherapeutic drugs due to the synergistic effect of pH responsiveness and tumor specific targeting in breast cancer. In a separate study, we have also demonstrated that curcumin-CHNPs with high biocompatibility and tumor targeting ability attenuate the cell migration and tumor growth through downregulation of PI-3 kinase dependent Akt activation leading to lowering of VEGF expression in breast cancer model. Overall, Raloxifene encapsulated RGD-CHNPs significantly reduced the breast tumor growth suggesting that RGD conjugated chitosan nanoparticles could be an effective approach for targeted therapeutic delivery in different sub-types of breast cancer.

Keywords: Breast cancer, Chitosan, Raloxifene, Tumor Growth.



Prof. Jianfeng Wang

Dept. of Architecture & Civil Engineering, City University of Hong Kong, Hong Kong

Prof. Wang is currently a full professor in the Department of Architecture and Civil Engineering at City University of Hong Kong. Prof. Wang is an internationally renowned expert in the field of micro-macro mechanics of granular materials. Prof. Wang has received a number of prestigious international research awards including: Scott Sloan Best Paper Award 2023 (Computers and Geotechnics);2025 Top 0.5% ScholarGPS (#63 in X-ray), World's Top 2% Scientists (Stanford's list) since 2022, 2023 Excellent Editorial Board Member Award from Journal of Rock Mechanics and Geotechnical Engineering, VEBLEO Fellow, and International Association of Advanced Materials (IAAM) Award, 2011 Geotechnical Research Medal (UK Institution of Civil Engineers), and 2010 Higher Education Institutions Outstanding Research Award - Natural Science Award (the Ministry of Education of China). Prof. Wang currently serves as an Associate Editor of Géotechnique, and Editorial Board Member of Computers and Geotechnics, Journal of Rock Mechanics and Geotechnical Engineering, and Soils and Foundations. So far Prof. Wang has published over 120 SCI journal papers and delivered over 40 keynote/invited lectures, and has a Google Scholar H-index of 44. Prof. Wang's work is reported by prestigious medias such as XINHUANET, CHINADAILY and Scientific Chinese.

Recognizing and matching crushed solid particles using X-ray computed microtomography

Jianfeng Wang[1], Zhiren Zhu[1], Mengmeng Wu[2], Zhuang Cheng[3], Bo Zhou[4]

[1]*City University of Hong Kong,* [2]*Hong Kong Polytechnic University*

[3]*Wuhan University of Science and Technology,* [4]*Huazhong University of Science and Technology*

Abstract

Based on the high-resolution X-ray computed microtomography (CT) testing of sand specimens, we have developed a series of advanced image recognition and matching techniques, which can be used to either recognize and restore intact or crushed sand particles, or achieve the full-field particle matching and tracking within a deformed specimen. For intact particles, the simplest technique is to use the particle IDs such as particle volume, surface area and polar radius distribution for particle recognition. On this basis, we proposed to use the spherical harmonics-based invariant, L2 norm, to construct the particle matching criterion, which was found to significantly improve the matching accuracy rate. Compared to intact particles, the recognition, matching and restoration of crushed particles are much more difficult. The main techniques used mainly include the point cloud registration (PCR), the main idea of which is to distinguish the newly generated fracture surfaces and the original particle surfaces, and then to match the fractured surfaces of crushed particles or to restore the complete morphology of the original particles by matching the partial surfaces of the crushed particles to the original particles. The PCR technique has been successfully used in the matching and restoration of crushed quartz sand particles. For more complicated sandy soils, we recently proposed the 3D signature of histograms of orientation (SHOT) for particle recognition and successfully used it to match crushed highly decomposed granite particles. Finally, for those sands with rich intra-particle pores such as carbonate sand, we proposed to use the deep neural network (such as PointNet++) for particle recognition and matching, and have achieved a preliminary success so far. The techniques developed in this study will also find important applications in nanomedicines and drug delivery.



Kantesh Balani

Materials Science and Engineering Dept., Indian Institute of Technology Kanpur, Kanpur-208016, U.P., India

Dr. Kantesh Balani is currently a full Professor, Lalit Mohan Kapoor Chair (2025-2028), and Head of the Department of Materials Science and Engineering at IIT Kanpur. He earned his doctorate in Mechanical Engineering from Florida International University, Miami, FL, in 2007. He has published ~200+ articles (h-index of 50, i-10 index of 170+) with 12,000+ citations in the peer-reviewed international journals and has presented 200+ talks in the national and international conferences and workshops. He is co-author of the book "Fundamentals of Thermal Spraying" (CRC Press, Nov. 2022), "Biosurfaces: From the Perspective of Materials Scientist and Engineer" (Wiley, 2015), and "Advanced Structural Ceramics" (Wiley, 2011). He has received several prestigious accolades such as "INAE Fellow 2021" by Indian National Academy of Engineering, "ASM Class of Fellow 2021", "FNASc Fellow 2021" by National Academy of Science India , Swarnajayanti Fellowship (2017-2022) by the Department of Science and Technology, Govt. of India; and Metallurgist of the Year (2016) by Ministry of Steel and Mines, Govt. of India; among others. He is reviewer of over 50 journals and serves as Editor-in-Chief of Nanomaterials and Energy (Institution of Civil Engineering) journal, Associate Editor of Journal of Thermal Spray and Technology (Springer), Principal Editor of Journal of Materials Research (Cambridge University Press) and Key Reader of Metallurgical and Materials Transactions A (Springer). His expertise areas of interest are processing and characterization of carbon nanotube (CNT) reinforced biocomposites, nanocomposites and nanotribology, coatings, and ultra-high temperature ceramics.

Designing Next Generation Sustainable Antibacterial & Cytocompatible Biocomposites

Kantesh Balani[1], Indrajeet Singh[1], Raj Kumar[1], Antrakrate Gupta[1], Shikhar K. Jha[1], Ing Kong[2], J. Ramkumar[1],

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Abstract

The development of multifunctional bioinks for printing scaffolds with adequate pore interconnectivity, porosity, mechanical properties, and antibacterial efficiency remains a challenge in tissue engineering. An integrated approach for designing the next generation of hydroxyapatite, bioactive glass, and alginate-based scaffolds for tissue engineering applications, featuring desirable mechanical properties, porosity, and antibacterial efficiency is presented herewith. Multifunctional hydroxyapatite (HAACZ) scaffold containing Ag, CeO2, ZnO exhibited an elastic modulus of 143.8 GPa, hardness of 10.8 GPa, porosity of 59.6% with interconnected micro and macro pores suitable for bone hard tissue replacement. Additionally, HAACZ scaffolds demonstrated an antibacterial efficiency of over 99% against E. coli and S. aureus, while maintaining effective cytocompatibility and apatite-forming capabilities. 3D printed Multifunctional bioglass (BGAC3D) scaffolds demonstrated a porosity of 64% with pore interconnectivity of 99%, featuring optimally designed pores of ≈400 µm with notable increase in elastic modulus (57.9 GPa), hardness (3.1 GPa), and compressive strength (1.5 MPa). Antibacterial efficiency of more than 99%, is observed alongside effective cytocompatibility with mouse bone marrow stromal cells and mouse fibroblasts, making it highly suitable for bone healing. Finally, a novel injectable hydrogel ink with sodium alginate, 58S bioglass, and MXene (Ti3C2Tx) was also developed. MXene's large surface area and functional termination enhance flowability and interfacial bonding, and mechanical integrity (43–55 kPa), while revealing antibacterial efficiency (91% against E. coli, 87% against S. aureus), while maintaining effective cytocompatibility ≤0.10 wt% loading. An optimized composition was achieved, balancing printing accuracy, antibacterial efficiency, and biocompatibility for soft tissue engineering applications. In addition, a direction to develop triply periodic minimal surfaces and porosity tailoring will also be touched upon.



Prof. Mauro Ferrari

President & CEO, BrYet US, Inc. USA

Dr. Ferrari has held senior leadership and academic positions spanning engineering, medicine, and cancer research. He served as President of the European Research Council in 2020 and previously as President and CEO of the Houston Methodist Research Institute, Executive Vice President of the Houston Methodist Hospital System, and a full professor affiliated with Weill Cornell Medical College. Earlier appointments included Special Advisor to the Director and Eminent Scholar at the National Cancer Institute and tenured faculty positions at UC Berkeley, The Ohio State University and The University of Texas Health Science Center and MD Anderson Cancer Center.. His scientific work includes seminal publications on cancer nanotechnology, nanofluidics, nanoparticle design, mesoporous silicon particles, transport phenotype targeting, and injectable nanoparticle generators. He has more than 500 publications to his credit, over 50 patents, and 7 books. Among his many recognitions are the Blaise Pascal Award from the European Academy of Sciences, and the Founders' Award of the Controlled Release Society. He earned a PhD and MS in Mechanical Engineering from the University of California, Berkeley, and a Dottore degree in Mathematics from the University of Padova.

The Plateloid Approach to Enable Cancer Phenotype Targeting

Mauro Ferrari

President and CEO, BrYet US Pharmaceuticals, Houston, USA

Affiliate Professor of Pharmaceutics, University of Washington, USA

Abstract

The immunological functions of platelets require a sequence of actions, including target site recognition on microvascular endothelia, the selective release of extracellular vesicles, and the local enhancement of their transendothelial and microenvironmental transport processes. Neither microscale biological structures such as platelets, no nanoscale entities such as the platelet-derived extracellular vesicles (P-EVs) are sufficient by themselves to perform the complete set of these coordinated functions. A tight integration of operations at the microscopic and nanoscopic scales is required for their successful accomplishment. We have devised and developed a therapeutic approach to lung and liver cancers that mimics these multi-step functionalities, deploying a sequence of actions bridging the micro- and the nanoscopic domains. Foundational to this approach is the Plateloid platform, comprised of fully bioerodible Nanoporous Silicon MicroParticles (NSMP) as a formulant for a single peptide-anthracycline conjugate in our lead drug, ML-016. The NSMP are mathematically designed using the principles of transport oncophysics, to achieve preferential concentration on the tumor-associated microvascular endothelia in the lungs and liver. The primary targeting mechanism for this enhanced concentration is based on the associated physics of lung and liver hemorheology, which is unlike what is found anywhere else in the body, and even more markedly so in the presence of neoplastic growth. Upon associating with the target endothelia, the peptide-anthracycline conjugate is released, and selectively penetrates the microvascular endothelium, facilitated by the properties of the transport peptide, poly-glutamic acid. In the tumor microenvironment, the peptide-anthracycline conjugate spontaneously forms exosome-like ("exosomoid") vesicles, which are enabled by their structure and composition to penetrate the target, otherwise therapy-resistant cancer cells by both passive and active transmembrane transport mechanisms. The anthracycline-carrying exosomoids are trafficked intracellularly. Upon reaching sufficiently acidic conditions in the late endosomal and lysosomal compartments, the pH-sensitive linker conjugating the peptide to the anthracycline is cleaved, leading to perinuclear release of the cytotoxic agent, where molecular and ionic multi-drug resistance pumps are minimally effective. Thus, a high concentration of active principle may penetrate the nuclear membrane, despite the very low concentrations anywhere else in the transport pathways from intravenous administration sites to the target therapy-resistant cancer cells. ML-016 thus accomplishes the objective of targeting the transport phenotype associated with lung and liver malignancies. In this talk, I will review the principles upon which the drug was designed, its preclinical evidence and the toxicity studies that lead to its approval for a Phase I/II clinical trial in patients with lung and/or liver cancer, both primary and metastatic, from primary cancers anywhere in the body. I will also illustrate the versatility of the NSMP platform to provide the foundations for novel therapeutic agents that include antibodies, their fragments, their conjugates to small molecule chemotherapeutic agents, radioligand therapeutics, and immunological approaches. The focus of my presentation will be on the nanotechnological approaches that are necessary to obtain phenotypical targeting for ML-016 and the NSMP-formulated therapeutic agents in this class. These include the manufacturing of the nanoporous architecture of the NSMP, and the nanoscale supramolecular chemistry leading to the spontaneous assembly of the peptide-anthracycline conjugate strands into exosomoid nanovesicles for penetration into otherwise therapy-resistant cancer stem cells.

Keywords: Nanoporous Silicon Microparticles, Phenotypic Targeting, Transport Oncophysics, Exosomoid Nanovesicles, Peptide-Anthracycline Conjugate, Drug-Resistant Cancer Cells



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Professor Nifantiev has published 500+ papers (h-Index – 55, Scopus) and was awarded with many national and foreign patents dealing with biologically active compounds and pharmaceutical products.

Recent interests have focused on the synthesis of complex oligosaccharides and neoglycoconjugates of medical interest, as well as the development of glycoconjugate vaccines, diagnostic test-kits and glycodrugs in the frame of start-ups and cooperation with industrial companies.

Achievements/Awards/Special: Professor Nifantiev was elected to be the Corresponding Member of the Russian Academy of Sciences (from 2011). He is the representative of Russia in the International Science Council (former ICSU) and also in the International and European Carbohydrate Organizations (ICO and ECO). He is also the member of Russian Chemical and Biochemical Societies and of the Editorial Boards of the Russian Journal of Bioorganic Chemistry (from 2001), Russian Chemical Bulletin (from 2009), Herald of the Russian Academy of Sciences (from 2018), Journal of Carbohydrate Chemistry (from 1999), Frontiers in Molecular Biosciences (2022) and some others. He is the Chairman of the Scientific Council on Organic Chemistry at the N.D. Zelinsky Institute, deputy-Chair of Scientific Council on Organic Chemistry, RAS. In IUPAC he served as the President (2020-2021) and Past-President (2022-2023) of the Division of Organic and biomolecular chemistry as well as the Chair of the Sub-committee on Organic Synthesis (2016-2021).

Development Of Automated Systems For Highly Specific Glycodiagnostics With Pg/ml-sensitivity Of Glycomarker Detection

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Abstract

Efficient automated glycodiagnostic systems are still required to meet the demands of clinical applications especially because of the dynamic growth of the number of test kits that detect glycomarkers. This is especially true for kits used in infectious clinical diagnostics. This lecture summarizes our recent works aimed at development of automated diagnostic systems for detecting anti-carbohydrate immunoglobulins and glycoantigens. The systems being developed are based on nanotechnology approaches and utilize surface-enhanced Raman spectroscopy (SERS)1-3 and fluorescence polarization4-8 as diagnostic signal recording methods. The results of this work will be demonstrated with examples of developed protocols for infectious diagnostics. Their creation required optimization of the structures of synthesized marker carbohydrate ligands and glycoconjugates based on them. This report presents new promising antigenic and serological markers of the most common and clinically significant fungal infections and bacterial infections, selected based on the analysis of carbohydrate structures on the fungal and bactrerial cell surface. As a result of synthetic, immunological, and biotechnological studies, highly specific antibody-based and antibody-free diagnostic protocols were developed, ensuring high selectivity and sensitivity (on pg/ml level) in detecting these markers.

Keywords: surface-enhanced Raman spectroscopy, fluorescence polarization, automated diagnostic systems, invasive fungal infections, synthetic oligosaccharides, diagnostic biomarkers

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Prof. Neeraj Sinha

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Prof. Neeraj Sinha is a distinguished biomedical researcher and Professor at the Centre of BioMedical Research (CBMR), SGPGIMS Campus, Lucknow. He has been associated with CBMR since 2007 and currently serves as its Director, a responsibility he assumed in December 2025.

He also serves as Professor and Dean of the Centre.Prof. Sinha completed his Ph.D. in Physics from the Indian Institute of Science (IISc), Bengaluru, in 2003, followed by postdoctoral research at Iowa State University and the University of California. He subsequently held academic positions at CBMR, progressing from Assistant Professor to Associate Professor and Professor.His research focuses on the development and application of Nuclear Magnetic Resonance (NMR) spectroscopy methodologies, including both solution-state and solid-state NMR, to address biomedical and human-health-related problems. His research interests include Acute Respiratory Distress Syndrome (ARDS), Chronic Kidney Disease (CKD), and osteoporosis.Prof. Sinha has made significant contributions to NMR-based metabolomics and biomedical spectroscopy, including research aimed at identifying disease-associated biomarkers and improving the understanding of disease mechanisms. He has served as Principal Investigator on research projects supported by agencies including the Science and Engineering Research Board (SERB), Department of Science & Technology, Government of India.He has published more than 100 research articles in peer-reviewed journals and continues to contribute actively to biomedical research, interdisciplinary collaborations, and translational science.

His recent research includes applications of solid-state NMR to understand biological materials such as collagen and extracellular matrix components.As Director of CBMR, Prof. Sinha is involved in advancing interdisciplinary research at the interface of basic science, clinical research and translational medicine, with an emphasis on developing technologies and scientific solutions that can contribute to improved human health.

Solid-State NMR Spectroscopy: Revealing the Inner Workings of Bones and Cartilage

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Abstract

Gaining structural and mechanistic insights into biomaterials such as bones and cartilage has long been challenging with conventional spectroscopic techniques. Solid-state NMR (ssNMR), however, offers unique advantages by probing these systems in their native state with picometer-level resolution. Diseases such as osteoporosis and osteoarthritis arise from subtle atomic-scale structural changes. To address this, our laboratory has developed a series of ssNMR-based experiments to investigate molecular interactions at the sub-atomic level. In particular, we have examined the structure of collagen proteins and their interactions with water and inorganic minerals in native systems. These studies have yielded novel insights into disease mechanisms and opened new avenues for therapeutic development.



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Zhang Qiang, a professor at the Changchun Institute of Applied Chemistry, Chinese Academy of Sciences. He has long been engaged in research on brain-computer interfaces and wearable biosensors, having published over 70 SCI papers, authored eight chapters in English monographs, and edited one English monograph. He holds nine authorized patents, two of which have been successfully commercialized. As a project leader, he has overseen 18 projects at the national, provincial, municipal, and industrial collaboration levels. Some of his research achievements have been highlighted by more than 130 media outlets, including China Central Television, Xinhua News Agency, Guangming Daily, and Global Times (English edition), with over 20 of them being national-level media. He has been selected for the National High-Level Youth Talent Program, recognized as a National Outstanding Measurement Leading Talent, and appointed to the Distinguished Research Professor position at the Chinese Academy of Sciences. He is also a high-level talent in Jilin Province, a recipient of the Jilin Province Mid-Career Innovation and Entrepreneurship Excellence Program, a Fellow of the International Association of Advanced Materials, and a Chem. Soc. Rev. Emerging Investigator. He was named a "Rising Star in Chemistry 2020" and has received numerous awards, including the Excellence in Science-Education Integration Mentorship Award from the University of Science and Technology of China, the Wiley 2022-2023 High Download Author Award, the Wiley 2021-2022 Highly Cited Author Award, the IAAM Young Scientist Medal, the Materials Horizons Outstanding Paper Award, and the Alberta Innovates Technology Futures Scholarship (Canada).

He currently serves as a member of the 7th China Young Scientists and Technicians Association, a member of its Basic Science Professional Committee, a member of its Achievements Transformation Professional Committee, a member of the Brain Science and Brain-Inspired Intelligence Professional Committee of the Guangdong Academy Association, and an editorial board member of Cell Reports Physical Science.

Fabrication of Electrochemical Sensors for Brain-Computer Interfaces and Sweat Analysis

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Abstract

Flexible and wearable sensors have recently found wide applications in health monitoring and human-machine interaction. Desirable features in wearable sensors are high sensitivity and multi-targets detection capability in non-invasive manners. The sensitivity and multi-analyte detection capabilities are a function of the sensing material and sensor structures. Herein, we utilize a single-layer microgels structure integrated into a wearable capacitive sensor to realize both high sensitivity and multi-targets detections. We established a responsive sensing chain of analytes-the conformational changes of polymer chains-the morphology changes of the single-layer microgels structure-device capacitive signals. The conformational changes of microgel polymer chains due to physiological signals and metabolites in body fluids induce measurable capacitive signals generated by the sensors. This work provides mechanistic insight into a stimuli-responsive chain of analytes induced molecular conformation and thus morphology changes that induce the capacitive signal in the wearable sensors. This multipurpose sensor platform demonstrates the ability to detect bacteria such as E. coli and B. subitilis, metabolites such as uric acid in sweat, and physiological signals such as sound recognition, respiration, and pulse beat.

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Prof. Pravindra Kumar

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Prof. Pravindra Kumar is a distinguished Indian scientist specializing in structural biology, biophysics, bioinformatics, enzyme engineering, protein engineering, and structure-based drug design. He is an Ashok Soota Institute Chair Professor in the Department of Biosciences and Bioengineering at the Indian Institute of Technology Roorkee (IIT Roorkee). His research focuses on understanding protein structure–function relationships and developing novel biocatalysts and therapeutic strategies, including applications in infectious diseases and the biodegradation of plastics and toxic compounds.Prof. Kumar received his Ph.D. in Biophysics (Structural Biology) from the All India Institute of Medical Sciences (AIIMS), New Delhi, in 2001, following his M.Sc. from C.C.S. University. He subsequently carried out postdoctoral research at Purdue University, USA, and joined IIT Roorkee in 2005. He has served in several academic and institutional leadership roles, including Head of the Department of Biosciences and Bioengineering.

His scientific contributions span protein–protein interactions, structural bioinformatics, enzyme mechanisms, protein engineering, novel biocatalysts, antimicrobial research, and structure-based therapeutic development. His research also explores sustainable biocatalytic approaches for environmental remediation.Prof. Kumar has received numerous national and international recognitions. He was elected Fellow of the National Academy of Sciences, India (NASI) in 2024 and Fellow of the Biotech Research Society, India (BRSI) in 2021. He received the National Bioscience Award from the Department of Biotechnology, Government of India, and the ASM–IUSSTF Indo-US Visiting Professorship in 2017. His other distinctions include the IUSSTF Award for organizing an Indo-US Conference and Symposium (2014), IUSSTF Indo-US Grant (2014), BOYSCAST Fellowship (2008), Visiting Scientist position at Purdue University (2006), and the S.V. Talekar Medal for Best Postgraduate Degree at AIIMS, New Delhi (2001).Through his interdisciplinary research, Prof. Kumar continues to contribute to advances in structural biology, biotechnology, therapeutics, and sustainable biocatalysis, with a strong emphasis on translating fundamental molecular insights into socially relevant applications.

Structure-Guided Engineering of EstS1 for Micro- and Nanoplastic Detoxification: A Preventive Nanomedicine Approach

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Abstract

Micro- and nanoplastics are emerging contaminants that can transport toxic additives and interact with biological barriers, potentially inducing oxidative stress, inflammation and endocrine disruption. Limiting human exposure to these nanoscale contaminants therefore represents an important dimension of preventive nanomedicine. Enzyme-based detoxification offers a sustainable solution, although its effectiveness depends on understanding how polymer chemistry, particle size and surface properties govern enzyme–substrate recognition and catalysis.

EstS1, a thermostable and pH-tolerant esterase from Sulfobacillus acidophilus DSM10332, exhibits broad activity against phthalate diesters, including the high-molecular-weight plasticizer bis(2-ethylhexyl) phthalate. High-resolution structures of apo EstS1 and its complexes with substrates, products and related analogues reveal a catalytic tunnel that controls substrate entry, catalytic positioning and product release. Structural characterization of EstS1 and its engineered variants provides valuable insights into enhancing access to micro- and nanoplastic-associated substrates and improving activity at polymer–water interfaces.

Structure-based molecular docking was employed to investigate the binding of phthalate diesters and representative oligomers derived from polyethylene terephthalate and other relevant polymers within the EstS1 catalytic tunnel. Molecular-dynamics simulations further evaluated ligand stability, tunnel flexibility and enzyme–substrate interactions. These computational predictions guided site-directed mutagenesis of tunnel-lining and substrate-recognition residues to enhance substrate affinity, catalytic turnover and activity toward micro- and nanoscale plastic particles.

By integrating structural biology, molecular modelling and protein engineering, this work establishes a framework for developing EstS1 as a preventive nanomedicine platform. Such engineered biocatalysts could support water purification, exposure mitigation and the sustainable management of plastic-associated health risks.



Prof. Rongjun Chen

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Prof. Rongjun Chen is an internationally recognized researcher in biomaterials engineering, nanomedicine, drug delivery, vaccines, and cell and gene therapy. He is Professor of Biomaterials Engineering in the Department of Chemical Engineering at Imperial College London, where he leads the Biomaterials and Nanomedicine Laboratory. His research focuses on the rational design, synthesis, and manufacturing of advanced materials and nanostructures for biomedical applications.Prof. Chen obtained his Ph.D. and conducted postdoctoral research at the University of Cambridge, in the Department of Chemical Engineering and Biotechnology.

He subsequently began his independent academic career at the University of Leeds, where he served as a Group Leader and BHRC Senior Translational Research Fellow, before joining Imperial College London in 2013.His research programme encompasses the development of polymer-, lipid-, and bio-inspired nanoparticles and nanoformulations for the targeted delivery of small-molecule and biomacromolecular therapeutics. Particular emphasis is placed on understanding and engineering the transport of therapeutic agents across extracellular and intracellular biological barriers. His work spans targeted nanomedicine, drug delivery, vaccine formulation, cancer treatment, thrombolytic therapy, and cell and gene therapy.

Prof. Chen has developed translational research programmes aimed at addressing important challenges in biomedical delivery, including the development of thermostable vaccine formulations and advanced delivery systems for RNA therapeutics.

His research has involved collaborations with academic institutions, industry, and biotechnology partners, supporting the translation of innovative nanomedicine technologies toward clinical applications.His scientific contributions have received international recognition, including the IChemE Global Team Award and the Imperial College President's Award for Outstanding Research Team in 2021. He also serves as an editor of the Chemical Engineering Journal.Through interdisciplinary research integrating chemical engineering, materials science, biology, and medicine, Prof. Chen continues to advance innovative nanomedicine and biomaterials technologies with potential applications in next-generation therapeutics and healthcare.

Nature-inspired Strategies for Biomacromolecule Delivery and Stability

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Abstract

Biomacromolecules are emerging as a powerful new class of vaccines and therapeutics, with the potential to address a wide range of diseases that remain difficult to treat. However, their clinical impact is often limited by challenges in targeted delivery, endosomal escape and favourable stability.
In this talk, we will explore how insights from natural biological systems, including viruses and biological molecules, can inform the design of advanced delivery platforms. By understanding how nature transports and stabilises biomolecules, we can develop new strategies to enhance the performance of macromolecular drugs.

The talk will present our latest work on the design, synthesis, and biological evaluation (in vitro and in vivo) of nature-inspired delivery systems. These platforms improve both the targeted delivery efficiency and stability of biomacromolecules, thereby offering a versatile foundation for next-generation vaccine and therapeutic development.

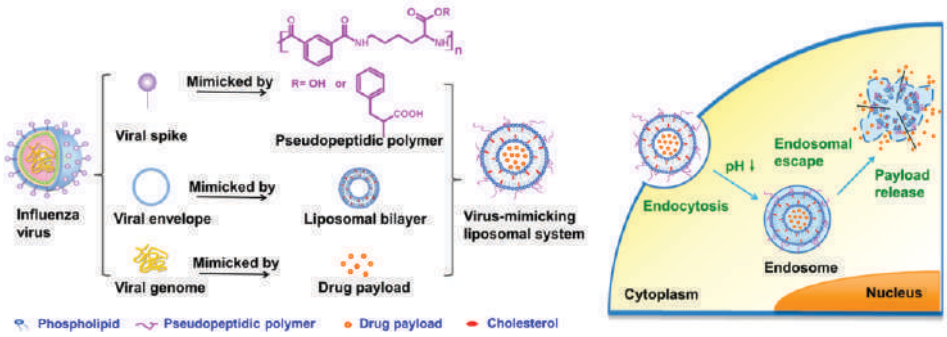


Figure. 1 One representative nature-inspired delivery system: virus-mimicking, pH-sensitive liposome and its endocytic pathway. The nanocarrier consists of the pH-responsive, endosomolytic pseudopeptide mimicking the fusogenic peptide in the viral spikes, the liposome mimicking the viral envelope, and the drug payload mimicking the viral genome.

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ANO Engineered Composites and Nano Hybrids for Highly Sensitive Label-free Bio Molecular Detection

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Abstract

Surface enhanced Raman spectrometry (SERS) has been established as a potential method to detect bio-chemical molecules with high sensitivity. The success of this technique depends on the preparation of appropriate substrate of SERS. This talk describes three nano dimensional materials systems as SERS substrates for detection of bio-chemical molecules, namely, (i) Metal-insulator nanocomposite films, (ii) 0D-2D nanohybrids and (iii) ultrathin metallic films (nanoislands). Au metallic nanoparticle with silica as a nanocomposite is used for detection of R6G molecules with high sensitivity. Synergistic plasmonic and chemical enhancement effects of 0D-2D nanohybrids to attain the high-intensity Raman signals of targeted analytes has been studies. These hybrids were successfully employed for achieving highly sensitive detection of the E. coli ATCC 35218 bacterial strains with a ppm level concentration.

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Dr Sahoo is a scientist at the Institute of Life Sciences, Bhubaneswar, India since 2005. He received his M.Sc. degree in 1994 and Ph. D in 1999 from the University of Delhi, Delhi. He served as a JSPS Postdoctoral fellow at the Department of Microbiology, School of Medicine, Kumamoto University, Kumamoto, Japan from 1999-2001. This was followed by a four-year postdoctoral fellowship at the Nebraska Medical Centre, Omaha, USA from 2001-2005 including a 2 years' fellowship from American Heart Association. Scientific Contributions include over more than 130 peer reviewed research papers including review articles and book chapters in leading scientific journals of the utmost quality in this field. Dr Sahoo has been granted 4 US patents; one EU patent on Nanotechnology based targeted drug and gene delivery. He is one of the experts in the field of Nanotechnology based drug delivery system mainly in the field of Cancer. Recently, one of the patented technology have been transferred to a Pharmaceutical company in India for commercialization. Dr Sahoo has also been featured as one of the top 2% scientists in the world in the field of Pharmacology and Toxicology (year 2020, 2021, 2022, 2023, 2024 and 2025) in a study by Prestigious Stanford University, USA. Scientific and Professional Activities includes, Editorial board member of Current Nanomedicine, Clinical & Experimental Pharmacology, Nanomedicine (future medicine), Serving Section Editor (cancer section) of Current Pharmaceutical Biotechnology and members of different scientific organizations.

Phytonanomedicine in Breast Cancer Therapy: Bench to Bedside and Beyond

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Abstract

Cancer remains the leading cause of death and rapidly evolving disease worldwide. The understanding of disease pathophysiology has improved through advanced research investigation, and several therapeutic strategies are being used for better cancer treatment. However, the increase in cancer relapse and metastatic-related deaths indicate that available therapies and clinically approved chemotherapy drugs are not sufficient to combat cancer. Further, the constant crosstalk between tumor cells and the tumor microenvironment (TME) is crucial for the development, progression, metastasis, and therapeutic response to tumors. In this regard, phytochemicals with multimodal targeting abilities can be used as an alternative to current cancer therapy by inhibiting cancer survival pathways or modulating TME. However, due to their poor pharmacokinetics and low bioavailability, the success of phytochemicals in clinical trials is limited. Therefore, developing phytochemical based nanomedicine or phytonanomedicine can improve the pharmacokinetic profile of these phytochemicals targeting tumor tissue and altering the characteristics of cancer stem cells, chemoresistance, TME, and cancer immunity for better cancer management.

Keywords: Phytonanomedicine, Drug Delivery, Tumor Microenvironment, Pharmacokinetics, Drug Resistance



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Dr. Sangram Keshari Samal is a researcher working in the field of biomaterials, nanobiotechnology and regenerative medicine, with a focus on developing advanced materials and therapeutic platforms for biomedical applications. He is affiliated with the Laboratory of Biomaterials and Regenerative Medicine for Advanced Therapies at the ICMR-National Institute of Health Research Centre, Bhubaneswar.His research interests include nanobiomaterials, tissue engineering, regenerative medicine, biomimetic scaffolds, hydrogels, drug and therapeutic delivery, biosensing, bioimaging and antimicrobial biomaterials. His work explores the design of functional materials with controlled structural, physicochemical and biological properties for applications in tissue regeneration and advanced therapies.Dr. Samal has contributed to research on porous and gradient scaffolds for tissue engineering and tissue regeneration, including approaches designed to mimic the architecture and properties of the extracellular matrix.

His recent work has examined advanced scaffold design and its potential applications in regenerative medicine.His research also encompasses nanomaterials and biomaterial-based therapeutic systems, including chitosan-based nanocomposites, carbon nanosheets, quantum-dot-based bio-nanohybrids and materials with potential applications in cellular imaging, biosensing and antimicrobial therapy.

Dr. Samal has published research in international peer-reviewed journals and collaborates across disciplines involving materials science, chemistry, biotechnology and biomedical engineering. His work contributes to the development of next-generation biomaterials and regenerative approaches aimed at translating advanced material technologies into biomedical and healthcare applications.

AI-Powered Digital Twins Technology in Designing Next-Generation Biomaterials for Personalized Regenerative Medicine

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Abstract

The demand for tissue and organ transplantation far exceeds the existing capabilities of organ donation and transplantation systems. Global statistics show that only about 10% of the demand for organs is met globally; the remaining 90% of patients face prolonged waiting periods or may never receive a desired transplant, contributing significantly to morbidity and mortality worldwide. Therefore, it is essential to explore alternative next-generation biomaterials integrated with stem cells with the required structural features and appropriate biomolecules may address current clinical challenges. However, the complex nature of biological tissues and the variability of patient-specific data remain a major challenge in designing an ideal next generation biomaterial. The use of Artificial Intelligence (AI) powered Digital Twins Technology (DTT) can offer a promising platform to design personalized next-generation biomaterials that can open a new era of possibilities for personalized regenerative medicine. AI-powered DTT will integrate real-time data from laboratory experiments, online databases, Internet of Things (IoT) devices, Machine Learning (ML) algorithms, and cloud platforms to generate advanced intelligence systems that will enable the design personalized next-generation biomaterials dynamic replica of a biological system that continuously integrates experimental, clinical, and patient-specific data to simulate and predict real-time outcomes to address existing complexities and clinical challenges. This system can simulate biomaterial physico-chemical and biological properties including predict cellular behavior, such as adhesion, proliferation, differentiation, immunomodulation, and extracellular matrix deposition. The AI-powered DTT will offer next-generation precision-patient-specific biomaterial for tissue and organ development, which represent a paradigm shift in personalized medicine. Although this technology appears very promising, it still needs substantial research for further future development.

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Prof. Satya Prakash

McGill University, Canada

Prof. Satya Prakash is a distinguished researcher and Professor in the Department of Biomedical Engineering at McGill University, Canada. He is also associated with the Department of Physiology, Department of Medicine/Experimental Medicine, and the Artificial Cells and Organs Research Centre. He serves as Director of the Biomedical Technology and Cell Therapy Research Laboratory at McGill University.His research is focused on artificial cells, biomaterials, microencapsulation, nanomedicine, regenerative medicine, tissue engineering, cell therapy, drug delivery, microbiome and probiotics, and biomedical device engineering.

His laboratory develops bioengineered and targeted delivery systems for therapeutic molecules, drugs, enzymes, DNA, cells and microorganisms.Prof. Prakash's research has explored innovative therapeutic approaches for metabolic disorders, cardiovascular health, neurodegenerative diseases, inflammatory bowel diseases, wound healing and cancer, as well as the development of artificial organ substitutes and advanced biomedical devices.

His work integrates bioengineering, tissue engineering, gene and cell therapy to develop new therapeutic technologies.He has an extensive record of scholarly and technological contributions, with more than 350 research articles and abstracts, 72 patents and three edited books, according to McGill's Biomedical Technology and Cell Therapy Research Laboratory. His research has contributed significantly to the development of probiotic and microbiome-based therapies, targeted drug delivery, regenerative medicine and advanced biomedical technologies.Prof. Prakash completed his Ph.D. at McGill University, with his doctoral research focusing on artificial-cell-based biomedical applications.

From RNA to Nanomedicine: Emerging Strategies for Cancer Therapy

Satya Prakash

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Abstract

RNA-based therapeutics offer a promising strategy for selectively modulating molecular pathways associated with cancer development and progression. Among these approaches, small interfering RNA (siRNA) has attracted considerable interest because of its ability to suppress disease-associated gene expression with high sequence specificity. However, translation of siRNA into effective cancer therapeutics remains limited by several challenges, including instability under physiological conditions, inefficient delivery to target tissues, off-target effects, and inadequate intracellular availability.

Nanoparticle-mediated delivery provides an attractive approach for addressing several of these limitations. Appropriately designed nanoscale delivery systems can protect RNA cargo, facilitate cellular uptake, and enhance localization and availability within target tissues while potentially reducing unwanted systemic effects. Our research has investigated nanoparticle-based strategies for delivering therapeutic siRNA in cancer, with particular emphasis on the relationship between formulation, delivery, biological activity, and therapeutic response. Studies conducted across experimental models have demonstrated the potential of this approach and provide a foundation for further translational development.

This presentation will discuss the scientific principles underlying nanoparticle-mediated RNA delivery, major challenges affecting therapeutic translation, and selected

Keywords: SIRNA, nanoparticles, RNA therapeutics, cancer, drug delivery, nanomedicine



Prof. Seyed E. Hasnain

National Science Chair, IIT Delhi; Distinguished Professor,
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Professor Seyed E. Hasnain has been an administrator, institution builder, policy maker and an active scientist. A Former Member of the Science and Engineering Research Board (SERB), Min of S&T, India; Governing Board of Ind Council of Med Res, he was Member, Science Advisory Council to Prime Minister of India (2004-2014); University Grants Commission, Chairman/Member of Governing Council/Academic Committee/Research Advisory Council/Board of Directors of prestigious institutions such as All India Institute of Medical Sciences (AIIMS), New Delhi, Institute of Liver and Biliary Sciences (ILBS), New Delhi, PGIMER-Chandigarh, Indian Institute of Science, Bangalore, AMU, JNU, etc. He is a Member of Aga Khan Foundation National Committee. Awards and recognitions include: Padma Shri (Civilian Award) from Indian President; Germany's Highest Civilian Award DasVerdienstkreuz, 1.Klasse awarded by German Chancellor (previous recipients include Nobel laureate Herman Muller, former German Chancellor Helmut Kohl, former Japanese Prime Minister Yasuhiro Nakasone and music conductor John Crosby, etc.); Humboldt Research Prize (Germany); G.D. Birla Award; Shanti Swarup Bhatnagar Prize from Prime Minister; Robert Koch Fellowship (Berlin); FICCI Award; BR Ambedkar Award; etc. Former Visiting Scientist at NERC Inst of Virology, Oxford, UK, Hasnain is an elected Member, German National Academy of Sciences, Leopoldina; Fellow, American Academy of Microbiology, USA; Fellow, TWAS (Italy); Fellow of Science Academies of India (FNA/FASc/FNASc), he has lectured extensively in almost all the countries of the world and received Honorary Doctorates from Universities in India and abroad, the 3rd Indian (Dr APJ Abdul Kalam, 2009, Dr Amartya Sen, 2010) to receive Honorary Doctorate (2011) from Queen's University, UK.

Hasnain is known not just for his contributions to infection biology, functional molecular epidemiology of the TB bacterium, but his research has impacted human health management, national economy, and the society at large. With >330 research publications (~16,000 citations, H-index=64), >3 dozen patents, he has mentored ~170 PhDs/MDs/Post-Doc students many of whom received prestigious Medals/Awards/coveted recognitions, including Director of ICDDRB, Dhaka (Bangladesh), Faculty/Scientist positions in India and abroad.

A Section Editor of PLoS ONE, he continues to be associated as Editor of journals including Scientific Reports, Infection Genetics & Evolution, Gut Pathogens, Frontiers group, etc. A former Visiting Scientist at the NERC Institute of Virology, Oxford, he was a Member of the International Advisory Board, Euro Patho Genomics Network of Excellence and Founding Patron of ISOGEM (International Society for Genomic and Evolutionary Microbiology, Italy).

Hasnain was the 1 st Director, CDFD (1999-'05), Vice Chancellor, Univ of Hyderabad (2005-'11) & Jamia Hamdard Univ (2016-'21). Invited Professor (2011-'19) and currently National Science Chair at Indian Inst of Technology-Delhi, and a Distinguished Professor at Sharda University, he leads a large, well-funded and active research group at Sharda on TB.

Is Global Elimination of the Disease Tuberculosis (TB) Possible?

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Abstract

Mycobacterium tuberculosis (M.tb), the Tuberculosis (TB) pathogen, is the deadliest bacteria known to humanity taking the largest toll of human lives globally, with a person dying every 15-20 seconds, despite being completely curable if diagnosed timely and treated properly. The problem with TB is further compounded by the development of drug resistance, including total drug resistance, HIV AIDS co-infection, diabetes epidemic and pandemics such as COVID-19. M.tb has undergone 'reductive evolution', over millions of years into a very slim and trim genomic and functional architecture while simultaneously expanding the unique PE-PPE_PGRS gene family. While shedding much of its genome it has balanced the genome deficit by resorting to very intelligent survival strategies - "more from less for more for its survival and pathogenesis.

My presentation will give specific examples of how M.tb is able to achieve "disruptive innovation" for its survival and pathogenesis. I will also try to give a flavor of efforts in our group combining computational, functional genomics, molecular epidemiology, infection biology and clinical approaches including new easy to use diagnostics, drug repurposing and engineered vaccines to block the extraordinarily clever strategies adopted by this bacterium.



Prof. Shin Aoki[1,2,3]

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A major research of Professor Shin Aoki of the Tokyo University of Science is the integration of organic chemistry, supramolecular chemistry, coordination chemistry, chemical biology, medicinal chemistry, and interdisciplinary research between them.

He has investigated multinuclear zinc complexes, molecular recognition, and self-assembly systems, which mimic the functions of natural enzymes to explore the essence of their catalytic reactions. Some of these functions have been applied to the drugs for radiation therapy of cancer to suppress acute side eUects of radiation therapy and to contribute to boron neutron capture therapy. Recently, his work focuses on the development of luminescent metal complexes and metal complex-peptide hybrids using cyclometalated iridium(III) complexes for application to cancer theranositics (diagnosis and treatment).

According to the researcher database of Tokyo University of Science, Prof. Aoki has published 167 peer-reviewed journal articles, 17 peer-reviewed proceedings, 21 books, approximately 770 conference presentations, and five patents.

His representative awards are the Award of Society of Coordination Chemistry (Japan) for Young Scientists (1999), the Ajinomoto Award in Synthetic Organic Chemistry (2001), The PSJ (Pharmaceutical Society of Japan) Award for Young Scientists (2002), the Best Researcher in Tokyo University of Science (2020), and the 2025 SPACC (Society of Pure and Applied Coordination Chemistry) Award (2026).

Design and Synthesis of Cyclometalated Iridium(III) Complexes for Applications to Nanoscale Medicine

Shin Aoki[1,2,3]

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Abstract

Metal complex-based theranostics are attracting significant attention in the diagnosis and treatment of diseases such as cancer, which maximizes the inherent and powerful multifunction of metal complexes. Cyclometalated iridium(III) (Ir(III)) complexes exhibit excellent photophysical properties that include large Stokes shifts, high emission quantum yields, and ms-emission lifetimes, due to low-lying metal to ligand charge transfer (spin-forbidden singlet-triplet (^{3}MLCT) transition).[1]) As a result, analogs have been applied not only to research in the material sciences such as the development of organic light-emitting diodes (OLEDs) but also those in photocatalysts, bioimaging probes, and anticancer reagents.

Although a variety of methods for the synthesis and the applications of functionalized cyclometalated Ir(III) complexes have been reported, functional groups are generally introduced to the ligands prior to the complexation with Ir salts. Therefore, it is difficult to introduce unstable functional groups including peptides and sugars under harsh reaction conditions such as the high temperatures used in the complexation with Ir salts. To overcome of this drawback, the functionalization of Ir(III) complexes after the formation of Ir(III) complexes and their biological and material applications has been developed, which is named "post-complexation functionalization (PCF)."[2]) In this paper, we present the design and synthesis of various types of Ir(III) complexes that function as red~blue luminescence emitters, inducers of programmed cell death in cancer cells, and so on, as followings.

References:

[1] Aromatic electrophilic substitution reactions of cyclometalated Ir(III) complexes for the introduction of various functional groups and control of emission colors.[2,3])

[2] Design and synthesis of Ir(III) complex-peptide hybrids (IPHs)[4,5]) and other organic compound-peptide hybrids for cancer theranostics.[6])

[3] Optical resolution of Ir(III) complexes and application to the synthesis of optically pure IPHs.[7])

[4] Synthesis of Ir(III) complex-dye hybrids and control of emission color and emission lifetime.[8])

We believe that this paper provides useful information for the design and synthesis of new types of cyclometalated metal complexes of not only Ir complexes but also other platinum metal group and their applications to biomedical science, material sciences and related fields.



Prof. Sylvain Martel

Professor, Polytechnique of Montreal
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Prof. Sylvain Martel is an internationally recognized researcher and pioneer in medical nanorobotics, micro- and nanosystems, and advanced biomedical intervention technologies. He is a Full Professor in the Department of Computer and Software Engineering at Polytechnique Montréal and Director of its NanoRobotics Laboratory. He is also affiliated with the Institute of Biomedical Engineering and McGill University.Prof. Martel holds a B.Ing. from the Université du Québec à Trois-Rivières and M.Sc.A. and Ph.D. degrees from McGill University. He is a Fellow of the Canadian Academy of Engineering and the IEEE, and has held a Tier 1 Canada Research Chair in Medical Nanorobotics.

His interdisciplinary research integrates robotics, biomedical engineering, microtechnology, nanotechnology, physics, and computer engineering.His pioneering research focuses on the development of untethered micro- and nanorobotic systems for medical applications, particularly targeted therapeutic delivery and minimally invasive interventions.

His research group has demonstrated controlled navigation of untethered objects within the blood vessels of living animals and has developed approaches using magnetically guided particles and magnetotactic bacteria as potential vehicles for targeted drug delivery.A major focus of his current research is the development of navigable therapeutic agents and novel interventional platforms for cancer treatment. His laboratory combines advanced magnetic actuation, medical imaging, micro-robotics, and biological systems to develop technologies capable of navigating through complex vascular networks and delivering therapeutic agents to specific disease sites. Recent work has also explored the navigation of magnetic microrobots in human-scale vascular environments.Through his pioneering research and interdisciplinary approach, Prof. Martel has contributed significantly to the emerging field of medical nanorobotics, with the broader goal of developing precise, image-guided technologies for next-generation diagnosis and therapy.

Nanorobotic agents for improving targeted drug delivery in cancer therapy

Prof. Sylvain Martel

Professor at Ecole Polytechnique of Montreal
Montreal, Quebec, Canada

Abstract

A major obstacle to optimal treatment outcomes is inadequate targeted drug delivery to active cancer cells. Systemically administered treatments that have no navigation capabilities or propulsive force do not generally accumulate inside tumors and, due to insufficient diffusion gradient combined with a high intratumoral interstitial fluid pressure, are unable to diffuse a sufficient therapeutic dose deeply enough within tumoral tissues to reach all active cancer cells, particularly those found within hypoxic regions of the tumor. To correct the deficiencies of current treatments delivery and targeting, research efforts in nanorobotics propose a different therapeutic delivery paradigm by embedding specific robotic functionalities within each therapeutic delivery vector. Based on the main limitations of current medical imaging and treatment modalities combined with physiological obstacles preventing adequate tumoral distribution of therapeutics, this plenary lecture will briefly show how nanorobotics dedicated to cancer therapy can contribute to enhance targeted delivery to maximize the therapeutic outcomes with minimum doses and systemic toxicity for the patients.



Prof. Sri Sivakumar

Indian Institute of Technology Kanpur, India

Dr. Sri Sivakumar is currently working as professor in department of chemical engineering, IIT Kanpur. He also serves as Associated Faculty in Materials Science Programme and Co- ordinator of Centre for Nanoscience and Advanced Imaging Centre. He obtained his B. Sc. (Tech) and M. Sc (Tech) degree from University Institute of Chemical Technology (ICT), Mumbai (formerly called as UDCT) in 1997 and 2001 respectively. Thereafter he obtained his Ph. D degree from University of Victoria in 2006. Dr. Sivakumar carried out his postdoctoral research at University of Melbourne. He has received also several awards, e.g. Class of 1979 Research Fellowship, Prof. CNR Rao best research paper award, Raj and Neera Singh Chair Professor, Chevron Corporation Chair Professor and Excellence in Teaching Award . Dr. Sivakumar's research focuses on development of functional nanomaterials for biological and environmental/catalytic applications. He has authored ~125 publications, 4 book chapters, 16 patents and edited one book.

Advanced In Vitro Liver Models for Drug-Induced Liver Injury and Transplantation

Prof. Sri Sivakumar

Indian Institute of Technology Kanpur, India

Abstract

The liver plays a central role in drug metabolism and is highly sensitive to drug-induced toxicity, creating a strong need for physiologically relevant in vitro models. In this work, we have presented two complementary strategies for advanced liver tissue modelling. First, a membrane-free liver-on-a-chip (MF-LOC) platform was developed using CGRGDS-modified PEGDA hydrogel to provide a native-like 3D microenvironment for encapsulated HepG2 hepatocytes and NIH-3T3 fibroblasts but also provide a platform for HUVEC monolayer formation under direct tangential flow. This architecture enabled efficient nutrient diffusion, mimic actual tissue organization, sustained albumin and urea secretion and prolonged CYP enzyme activity outperforming conventional invitro models. The platform successfully modelled acetaminophen-induced liver injury and therapeutic recovery with N-acetylcysteine and curcumin showing rapid functional restoration. In addition, sound-induced morphogenesis was employed to fabricate vascularized liver tissue with microcapillary ring architectures enhances oxygen and nutrient transport in turn improving liver-specific functions. Together, these approaches offer scalable and predictive platforms for drug screening, DILI assessment and advanced liver tissue engineering for transplantation.



Prof. Sujata Mohanty

All India Institute of Medical Sciences (AIIMS), New Delhi, India

Prof. Sujata Mohanty is a distinguished researcher in the field of stem cell biology and regenerative medicine at the All India Institute of Medical Sciences (AIIMS), New Delhi. She has been instrumental in establishing and developing the Stem Cell Facility at AIIMS and currently serves as Professor and Faculty-in-Charge of the facility.Her research focuses on adult and embryonic stem cells, mesenchymal stem cells, induced pluripotent stem cells (iPSCs), tissue regeneration, stem-cell-based therapeutics, and drug discovery. Her work encompasses stem cells derived from sources including bone marrow, umbilical cord, adipose tissue, dental pulp, skin and hair follicles. She has also contributed to research on stem-cell-derived extracellular vesicles and their potential applications in regenerative medicine.

Prof. Mohanty has contributed extensively to basic, preclinical and translational stem cell research, as well as to the training of researchers and students in stem cell technologies.

Her research contributions have resulted in numerous peer-reviewed publications and collaborations in the fields of regenerative medicine, tissue engineering and cellular therapies.She has received several honours, including the AIIMS Excellence Award for notable published research work and recognition from the International Society for Stem Cell Research (ISSCR). She has also served on various national and international scientific, advisory and research-review committees related to stem cell research and regenerative medicine.

Stem Cell Meets Nanotechnology: Next-Gen Theranostics

Sujata Mohanty

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Abstract

Nanotechnology and Stem Cell Research holds tremendous potential in the treatment of several degenerative diseases. Mesenchymal Stem Cells (MSCs) are present in different tissues and organs like bone marrow, umbilical cord, adipose tissue and placenta. Stem cells are not just a clump of cells, they harness the ability to repair damaged or diseased tissue. Thus, stem cells have significant importance in regenerative medicine. Various mechanisms through which MSCs play a vital role in repair and regeneration include immunomodulation, trans-differentiation, paracrine factors, etc. The discovery of the regenerative potential of MSCs has been taken from the bench to bedside to treat various diseases like vitiligo, eye disorders, etc. However, their appropriate application from bench to bed side is a major challenge.

Nanomaterials harnesses the potential of stem cells for biotherapeutic applications, by working at the size scale of molecules and processes governing the fate of stem cells. Materials at the nano level hold unique features like large surface area-to-volume ratio providing large space for successful interaction with cells. The nano level interaction of the material with stem cell helps in stem cell differentiation, labeling, tracking and therapy. Following this, we fabricate various biomaterials using polymers and their nano-based composites and test their ability to differentiate MSCs into a particular lineage.

In the Stem Cell Facility, we fabricate various nanomaterials by using natural polymer, synthetic polymer and stem cell byproducts such as stem cell-derived extracellular vesicles for mesenchymal stem cell differentiation in to desired lineages. The nano-biomaterials are being designed by using different techniques like freeze-drying, electrospinning and ultracentrifugation.

In my talk, I shall be discussing about the various properties of MSCs in regenerative medicine and biomaterials focusing on nano materials in stem cell mediated tissue regeneration. I shall be discussing about the present scenario of biomedical engineering research and will be focusing on some basic tissue engineering techniques for stem cell adhesion, proliferation, differentiation and interaction of stem cells with the engineered nano-biomaterials. Therefore, the main emphasis of the talk will be on the current research status at basic and translational levels and the future prospects of nanotechnology on stem cells functioning in advance health care system.



Prof. Suresh K. Sahni

Department of Chemistry & Environmental Science William Paterson University, Pompton Road Wayne, NJ 07470 USA

Dr. Suresh K. Sahni is a chemist and researcher associated with the Department of Chemistry at William Paterson University of New Jersey. His academic and research contributions span several areas of inorganic, coordination and materials chemistry, with particular emphasis on the chemistry of metal complexes, chelating ion-exchange materials, sensors and biomaterials.

His research interests include coordination chemistry, water treatment, ion-exchange resins, organometallic chemistry, electrochemical biosensors, fiber-optic sensors, homogeneous and heterogeneous catalysis, energy-storage materials, dental materials and radiopaque biomaterials, and metal-based contrast agents.Dr. Sahni has contributed to research on metal complexes and functional materials, including studies of transition-metal complexes, chelating resins and ion exchangers, polymeric luminophores for sensing applications, and metal-containing materials. His publications demonstrate a broad interest in applying inorganic and coordination chemistry to environmental, biomedical and technological applications.

He has also participated in undergraduate research activities at William Paterson University, serving as a judge and mentor in university research symposiums across areas including analytical chemistry, nanochemistry and materials chemistry.His work reflects an interdisciplinary approach connecting fundamental chemistry with environmental remediation, sensing technologies, biomaterials and biomedical applications.

Radiopaque Nanomaterials and Nano Biomedicine: Current Status

Suresh K. Sahni and Sonu Sahni

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Abstract

Radiopaque nanomaterials have been evolving as a fast-developing class of nano biomedicine from passive X-ray contrast agents into multifunctional biomedical platforms. These mainly metal-containing systems take advantage of strong X-ray attenuation of higher atomic-number (high Z) elements like gold, bismuth, tantalum, hafnium, tungsten, and selected lanthanides to improve upon traditional radiopaque contrast agents based upon small molecule iodinated compounds, suffer from critical clinical limitations such as rapid renal clearance, lack of tissue specificity, and potential systemic toxicity. Metal-containing radiopaque nanoparticles can package large numbers of attenuating atoms within a single construct while simultaneously controlling circulation time, tissue distribution, cellular uptake, molecular targeting, and therapeutic payload delivery. These nano-structured formulations have been investigated as next generation computed tomography (CT) diagnostics (molecular and cellular CT, photon counting and multicolor CT and blood pooling imaging and angiography, molecular imaging probe), multifunctional cancer theragnostic (image-guided therapy), radiosensitizers, longitudinal tracking of biodegradable polymeric implants, vascular interventions and real-time embolization (including photopolymerized radiopaque embolic microparticles), and renal functional imaging as an emerging application. Radiopaque nanomaterials have developed from dense particles designed to increase CT signal into biologically engineered nanomedicines capable of molecular recognition, quantitative spectral imaging, functional assessment and radiation enhancement.

Despite several promising results in preclinical studies, these versatile potential radiopaque nanomedicines need intensive work to become regular clinical biomaterials. The challenges and future directions include long-term clearance, b) nanotoxicology and mononuclear phagocyte (MPS) uptake, and manufacturing scalability to achieve perfectly uniform nanoparticles and a homogeneous distribution inside polymeric medical devices remains technically challenging on a commercial scale. Chemical synthesis and surface modification pathways for converting nano-radiopaque elements from raw heavy metals into highly dispersed, stable biomedical formulations, strict control over structural nucleation and interfacial chemistry is required. Nanoparticles are primarily fabricated through bottom-up wet-chemical reduction or green synthesis techniques, followed by custom surface modification to suit biological behavior. The core synthesis methodologies include reduction, green and sustainable synthesis to bypass toxic chemical reducers (like sodium borohydride). Green synthesis uses plant-derived polyphenol extracts, and thiol-PEG functionalization (PEGylation)- the gold standard for stabilizing heavy-metal cores involves anchoring poly(ethylene glycol (PEG) chains and polymer encapsulation.



Prof. Tej P. Singh

AIIMS New Delhi

(Dept. of Biophysics)

Tej P. Singh (PhD, 1975, Indian Inst. of Science, Bangalore) is SERB-Distinguished Fellow, Dept. of Biophysics, All India Inst. of Medical Sciences, New Delhi. His honours include: Prof. DM Bose Memorial Lecture Award, Bose Inst. (2013); Bhramara's YT Thathachari Award in Life Sciences (2012); Jawaharlal Nehru Birth Centenary Lecture Award, INSA (2011); Goyal Prize in Life Sciences (2007); Prof. GN Ramachandran CSIR Gold Medal for Excellence in Biol. Sciences and Technology (2006); Prof. GN Ramachandran 60th Birthday Commemoration INSA Medal (2006); Sir JC Bose Memorial Award, Indian Science Congress (2006); KK Foundation Award for Sci. and Tech. (2001). He is a fellow of: Indian Natl. Science Acad. (INSA); Indian Acad. of Sciences; Natl. Acad. of Sciences, India; Biotec Research Soc. of India. He was Vice-President, INSA (2007-2009) and Editor-in-Chief, Proceedings of INSA (2011-13).

Beyond Prediction: Why experimentally determined protein structures remain essential for drug design

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Abstract

Adenosine triphosphate phosphoribosyltransferase (ATP-PRT) catalyses the first and committed step of histidine biosynthesis, transferring the phosphoribosyl group of phosphoribosyl pyrophosphate (PRPP) to ATP to form phosphoribosyl-ATP (PR-ATP). Here, we report the crystal structure of the short-form ATP-PRT from Acinetobacter baumannii (AbHisGS), revealing distinct sites for metal sequestration and substrate recognition. The two crystallographically independent molecules form an antiparallel homodimer, with ATP and PRPP binding at the dimer interface and a Mg^{2+} ion positioned between the substrates, consistent with its role in facilitating their productive association. Unexpectedly, a second metal-binding site was identified at the N terminus, where a sodium ion is octahedrally coordinated by the backbone carbonyl oxygen of Asn16 and five water molecules. In contrast, the substrate-binding site is accessed through a wide, electrostatically favorable entrance formed by inward-projecting Lys51 residues from the two protomers, which may facilitate recruitment of the negatively charged substrates. Substrate accumulation at this site is predicted to progressively increase the local negative electrostatic potential, potentially favoring recruitment of a hydrated metal ion from the N-terminal sequestering site. A continuous network of protein residues and ordered water molecules connects the two sites, suggesting a structurally preorganized pathway for metal-ion transfer. Together, these findings reveal an unexpected spatial and electrostatic coupling between substrate recognition and metal-ion recruitment in ATP-PRT. The distinct organization of the metal-sequestering and substrate-binding sites also provides a structural framework for their independent exploitation in structure-based inhibitor design



Prof. Thomas Wong

Illinois Institute of Technology, USA

Thomas Wong read electrical engineering at the University of Hong Kong and did graduate work in microwave measurement of materials at Northwestern University. He joined the faculty of Illinois Institute of Technology in 1981 and is currently an emeritus professor. He has served as graduate program director in electrical and computer engineering, department chairman, and chair of the faculty council. His research has mainly been in applied electromagnetics, microwave instrumentation, and material characterization. He has been involved in the planning, development and mentoring in an interdisciplinary project-based learning program for two decades. He is the author of Fundamentals of Distributed Amplification (Artech, 1993), co-author of Electromagnetic Fields and Waves (Higher Education Press, 2006 & 2012), and originator of several patents in microwave electronics and wireless systems. He is a Fellow of the International Association of Advanced Materials and the Institute of Electrical and Electronics Engineers.

Semiconductor Nanoparticles as a Mediator for Functional Applications of Terahertz Electromagnetic Fields

Thomas Wong

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Abstract

Surface plasmon resonance in metallic nanoparticles (MNP) have led to numerous applications in sensing, waveguiding, and biomedical applications of MNPs and their derivatives in the optical region. With a lower charge concentration, hence a correspondingly lower bulk plasma frequency, semiconductor nanoparticles (SNPs) have attracted recent interest for device and component development in the terahertz and far infra-red frequency range. While the response in non-degenerate SNPs is weaker than their metallic counterpart, SNPs can have their charge concentration varied by doping or otherwise, offering an additional degree of freedom in their design and preparation, leading to a wider range in properties. Penetration of an electric field into a semiconductor nanoparticle is more substantial than for a metallic nanoparticle, giving rise to space charge interactions in the interior region. To properly account for field penetration effects, a transport formulation for charge dynamics is needed to characterize field-charge interactions for SNP and its derivatives. By coupling the Boltzmann equation to the Maxwell equations, space charge interactions in SNPs are quantitatively revealed by the charge density, field intensity, and current distribution, while the induced dipole moment as a collective response from the nanostructures can readily be computed. While the analysis and simulation are effectively facilitated with computational tools, the complexity of the numerical implementation grows rapidly with the number of elements in the nanostructures. To simplify the simulation procedure, equivalent circuits in conjunction with network theory can be introduced for studies on the dynamical response of SNP and its derivatives to excitations by a terahertz electric field. Based on this formulation, a scheme for analysis, characterization, and synthesis of nanostructures with capabilities to meet with functional requirements for technological applications has been developed. In this presentation, the terahertz polarizations in elementary nanostructures derived from SNPs are presented and their potential for device and diagnostic applications are explored.



Prof. Thomas J. Webster

Professor, Purdue University,
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Thomas J. Webster's (H index: 139) degrees are in chemical engineering from the University of Pittsburgh (B.S., 1995; USA) and in biomedical engineering from RPI (Ph.D., 2000; USA). He has formed over a dozen companies who have numerous FDA approved medical products currently improving human health in over 45,000 patients. He is currently helping those companies and serves as a professor at Brown University, Saveetha University, Hebei University of Technology, UFPI, University of the Basque Country, and others. Dr. Webster has numerous awards including: 2020, World Top 2% Scientist by Citations (PLOS); 2020, SCOPUS Highly Cited Research (Top 1% Materials Science and Mixed Fields); 2021, Clarivate Top 0.1% Most Influential Researchers (Pharmacology and Toxicology); 2022, Best Materials Science Scientist by Citations (Research.com); and is a fellow of over 8 societies. Prof. Webster is a former President of the U.S. Society for Biomaterials and has over 1,350 publications to his credit with over 55,000 citations. He was recently nominated for the Nobel Prize in Chemistry. Prof. Webster also recently formed a fund to support Nigerian student research opportunities in the U.S.

Returning Mobility to Over 45,000 Patients Using Next Generation Biomaterials

Prof. Thomas J. Webster

Division of Pre-college and Undergraduate Studies, Brown University, Providence, RI USA; School of Health Sciences and Biomedical Engineering, Hebei University of Technology, Tianjin, China; School of Engineering, Saveetha University, Chennai, India; Department of Pharmacy, The University of the Basque Country, Vitoria-Gasteiz, Spain

Abstract

Nanomedicine is the use of nanomaterials to improve disease prevention, detection, and treatment which has resulted in hundreds of FDA approved medical products. While nanomedicine has been around for several decades, new technological advances are pushing its boundaries. For example, this presentation will present an over 30 year journey of commercializing nanomaterials for orthopedic implants now in over 45,000 patients to date showing no signs of failure. Current orthopedic implants face a failure rate of 5 – 10% and sometimes as high as 60% for bone cancer patients. Further, this talk will present future research directions into using atomic layer deposition (ALD) to create such nanostructures on implants to reduce infection and improve bone growth. Sensors grown off of orthopedic implants using ALD will also be discussed in which cell presence on orthopedic implants can be detected and quantified. Such information can also be communicated to a handheld device to better inform surgeons on chances of implant success or failure. Such sensors can also release pharmaceutical agents and/or nanoparticles on-demand to ensure implant success. Lastly, this talk will cover how Artificial Intelligence (AI) can be combined into today's orthopedic implants to predict implant success or failure in the years that follow.



Prof. Vibha Tandon

Director, CSIR-Indian Institute of Chemical Biology (IICB), Kolkata

Prof. Vibha Tandon is a distinguished Indian scientist and academician with extensive research experience in chemical biology, medicinal chemistry, molecular medicine, drug discovery, and radiation biology. She currently serves as the Director of CSIR-Indian Institute of Chemical Biology (CSIR-IICB), Kolkata, a premier national research institute dedicated to interdisciplinary biomedical research.

Prof. Tandon completed her Ph.D. in Chemistry and has held several academic and research positions during her distinguished career. She served as a Professor at the University of Delhi and subsequently joined the Special Centre for Molecular Medicine at Jawaharlal Nehru University (JNU), New Delhi, where she continued her research and academic activities. She took charge as Director of CSIR-IICB in November 2023.

Her research lies at the interface of chemistry and biology, with particular emphasis on the design and development of biologically active small molecules. Her research programme encompasses drug discovery, cancer biology, radiation biology, cell signalling, genomics and proteomics, as well as the development of novel antimicrobial agents. Her laboratory has investigated small molecules for applications in cancer, cancer radiotherapy, bacterial infections, and HIV-1 infection.
Under her leadership, CSIR-IICB continues to pursue multidisciplinary research spanning cancer biology, infectious diseases and immunology, cell biology, pharmacology and drug discovery, organic and medicinal chemistry, and structural biology and bioinformatics.

A significant area of her research involves the development of new antimicrobial strategies targeting bacterial DNA topoisomerases, with the objective of addressing antibiotic resistance. Her work has contributed to identifying novel molecular targets and chemical entities with potential therapeutic applications.

Prof. Tandon's career reflects a sustained commitment to translational research, scientific innovation, and the development of new therapeutic approaches, strengthening the interface between chemical sciences and biomedical research.

Identification of MUCIN 7 as Tumor Suppressor and Diagnostic Biomarker in Oral squamous Cell Carcinoma followed by Therapeutic Intervention by Small Molecule

Vibha Tandon

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Abstract

Integrating multi-omics analysis of tumors from 22 Indian OSCC patients with single-cell RNA sequencing of patient-derived spheroids (n=6), we reveal that the loss of Mucin 7 (MUC7) drives tumorigenesis and worsens disease outcomes. MUC7 was significantlydownregulated in tumour tissues compared to adjacent normal, consistent with TCGA data(n=520 tumour; n=44 normal), where expression dropped from 5 TPM to 0.028 TPM. RT-PCR showed 3–5-fold downregulation in tumors and 1.8-fold upregulation in adjacent tissue, confirmed by western blot. SAS-MUC7 cells showed slower proliferation, reduced Ki-67 levels, and increased cisplatin sensitivity. At 6 Gy radiation, SAS-MUC7 cells had reduced apoptosis and necrosis, along with elevated E-cadherin (7-fold) and reduced Vimentin (0.07 fold). Treatment with Suberoylanilide Hydroxamic Acid (SAHA) of SAS-MUC7 showed decreased E-cadherin and Muc7 expression leading to EMT shift in treated cells. Interestingly, AQP5 was notably elevated in SAS-MUC7 cells. IHC of xenografts showed 10.24- and 7.58-fold higher MUC7 expression in SAS-MUC7 in comparison to SAS and PDX tumors. SAS-MUC7 xenografts exhibited delayed tumor growth and improved median survival. DMA a small molecule showed increased survival of OSCC tumour bearing treated mice as compared to untreated one.

Invited Speakers



Amit Kumar Pandey

Department of Biotechnology, National Institute of Pharmaceutical Education and Research (NIPER)-Ahmedabad, Palaj Gandhinagar, Gujarat 382355, India.

Dr. Amit Kumar Pandey is an Associate Professor in the Department of Biotechnology at the National Institute of Pharmaceutical Education and Research (NIPER), Ahmedabad. His research focuses on cancer biology, molecular oncology, long non-coding RNAs (lncRNAs), cell signalling, metabolomics, and lipidomics.

His work aims to understand the molecular mechanisms involved in cancer development, progression, and therapeutic response.His research interests include studying the role of lncRNAs in triple-negative breast cancer, glioblastoma, and ovarian cancer, with particular emphasis on their interaction with key signalling pathways and their potential as diagnostic and therapeutic targets. His research also involves advanced approaches such as 3D cancer spheroid models, metabolomic and lipidomic profiling, and CRISPR/Cas9-based gene editing.Dr. Pandey has received research support from national funding agencies and has published extensively in peer-reviewed international journals. He has also been recognized for his contributions to cancer research and is actively involved in mentoring postgraduate and doctoral researchers.

His work integrates molecular biology, genomics, and systems-level approaches to advance the understanding of cancer biology and identify novel strategies for cancer diagnosis and therapy

Targeting the MANCR–miR-205-5p–CASP3 Axis in Glioblastoma: A Molecular Framework for Precision Nanomedicine and Therapeutic Development

Amit Kumar Pandey[1] and Binita Patel[1]

[1]*Department of Biotechnology, National Institute of Pharmaceutical Education and Research (NIPER)-Ahmedabad, Palaj Gandhinagar, Gujarat 382355, India.*

Abstract

Background: Glioblastoma (GBM) is an aggressive primary brain tumor characterized by rapid progression, extensive infiltration, and poor clinical outcomes. Long non-coding RNAs (lncRNAs) are increasingly recognized as important regulators of tumor biology; however, the functional and mechanistic contribution of many lncRNAs to GBM remains poorly understood. We investigated the role of the long non-coding RNA MANCR in GBM progression and explored its underlying molecular mechanism.

Methods: Differential lncRNA expression analysis was performed using transcriptomic datasets to identify dysregulated candidates in GBM. MANCR expression was subsequently validated in GBM cell models by RT-qPCR. Functional effects of MANCR depletion were evaluated using colony formation, Transwell migration, and soft agar assays. Pathway enrichment and protein–protein interaction analyses were performed to identify potential downstream molecular pathways. The involvement of CASP3 and miR-205-5p was investigated using expression analysis, survival/correlation analyses, Western blotting, miRNA manipulation, and Ago2 RNA immunoprecipitation.

Results: MANCR was identified as a dysregulated lncRNA in GBM and demonstrated clinical relevance in patient datasets. MANCR expression was validated in GBM cellular models, and its silencing significantly reduced colony-forming, migratory, and anchorage-independent growth capacities. Pathway analysis implicated apoptosis as a major biological process associated with MANCR depletion. MANCR silencing increased CASP3 and cleaved CASP3 levels, suggesting enhanced apoptotic signaling. Mechanistically, MANCR was associated with miR-205-5p regulation, and Ago2-RIP supported an interaction between MANCR and the miRNA regulatory machinery. Functional modulation of miR-205-5p further supported its role in mediating MANCR-associated phenotypes.

Conclusion: Our findings identify MANCR as a potential regulatory lncRNA contributing to GBM aggressiveness through a miR-205-5p-associated apoptotic pathway involving CASP3. This MANCR-centered regulatory axis may provide a potential molecular framework for understanding GBM progression and identifying novel therapeutic targets.



Dr. Anwar Alam

Associate Professor and Head- Advanced Center for Translational Research
Sharda University, Greater Noida, India

Dr. Anwar Alam is the Head of the Advanced Center for Translational Research, Sharda University.

Dr Anwar Alam completed his Ph.D from Jawaharlal Nehru University, New Delhi. He has more than 16 years of experience in research and 6 years in academic teaching. His area of specialization is Nanoparticle based drug-targeting and Infectious biology. He earlier worked as project Scientist at the ICMR-National Institute of Pathology (ICMR-NIP) and Department of Biochemical Engineering & Biotechnology, IIT-Delhi. He was a member of ICMR-NIP core team for COVID-19 management, where he played key role in establishing central depot for disbursement for COVID-19 kits across India, established Biosafety labs for SarsCoV-2 testing and kit validation. He has successfully completed projects funded by GoI Agencies including DBT, DST and ICMR. The main thrust of research in these projects were to explore the epidemiology and multi-drug resistance of TB using Next-generation Sequencing, develop new chemical entities including drug-repurposing and host directed therapies for effective medical interventions. He is part of team that has developed a first-in class drug to target latent TB bacilli. He is currently leading a team of PhD scholars, researchers including post-doc Scientists in several extramural projects on Development of Biomarker for screening TB, AI ML based prediction of multi-drug resistance, testing of a low-cost field deployable tool for TB detection and Anti-microbial resistance. He has filed several more than 7 patents that includes medicaments for treatment of infections caused by biofilm forming pathogens and recombinant multi-epitope vaccines.

Dr Anwar has been conferred with Young Scientist award by the Microwave Applications Society of India. He is the Life Member of Indian Immunology Society, Indian Society of Cell Biologist, Indian Association of Cancer Research and member of the Editorial Board of the Frontiers Journal and Nature Journals.

New Diagnostic and Therapeutic Intervention strategies against Tuberculosis: a multifaceted approach for overriding M.tb resilience

Anwar Alam

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Abstract

Mycobacterium tuberculosis (M. tb) infects approximately 1.5 million people worldwide and India accounts for nearly 25% of the MDR-TB cases. With an aim towards END-TB vision, novel and multifaceted strategies are required to cover the aspects of prevention, early detection, and cure. Repurposing existing vaccine and drugs can complement the development of new drugs for expanding the arsenal against Mycobacterium tuberculosis. We have tested a novel device SeeTB, developed in collaboration with IIT Delhi, across India. This low cost, field deployable device (at TRL-6/7) stage requires minimal interventions for converting a light microscope into a fluorescence detection device, allowing detection of bacilli. The detection efficacy as compared with GeneXpert and MGIT, results point to more than 90% sensitivity and specificity. A new drug DRILS1398 has shown efficacy in clearance of M.tb in infected animals (iScience 2025). Using polypharmacological approach, we tested FDA approved drugs against M.tb strains, wherein the aim was to target multiple M.tb proteins simultaneously using a single drug/adjunct, so that pathogen's ability to subvert pathways for evolving is choked. With this strategy in place, we have repurposed host-directed drugs that have bactericidal effect and when used as adjunct with ATT drugs, reduces the duration of treatment therapy significantly. Complete clearance of infection was observed using these drugs.

Keywords: Drug Repurposing, New Chemical Entity, MDR-TB, Polypharmacology, Tuberculosis



Dr. Asmita A. Mehta

Professor & Head, Respiratory Medicine
Amrita Institute of Medical Sciences, Kochi

Dr. Asmita A. Mehta, Professor & Head, Department of Respiratory Medicine, Amrita Hospital, Kochi, Kerala, India

Professor and Head of Respiratory Medicine at Amrita Hospital, Kochi, with a major clinical and academic focus on ILD. Leads a large ILD clinical programme and database and convenes the PAN-INDIA ILD Multidisciplinary Discussion. Section Editor (ILD), Journal of PACS. Guest member, ERS Clinical Research Collaboration TRANSLATE-ILA, and contributor to international ILD initiatives including ATS GILD Standards. Invited faculty at national and international respiratory meetings, including WCBIP 2026. Her research interests include ILD biomarkers, artificial intelligence in thoracic imaging, progressive pulmonary fibrosis, sarcoidosis and standardisation of ILD multidisciplinary care. She has led and collaborated on multiple peer-reviewed publications and consensus projects, including consensus recommendations for standardising ILD multidisciplinary discussions in India.

Nanotechnology in Respiratory Medicine: From Diagnostics to Targeted Therapy

Dr. Asmita Mehta

Professor & Head, Respiratory Medicine
Amrita Institute of Medical Sciences, Kochi

Abstract

Nanotechnology is increasingly moving from the laboratory into clinical respiratory medicine, offering new approaches to both diagnosis and targeted therapy. The lung is particularly suited to these technologies because of its large surface area, thin air–blood barrier and direct accessibility for drug delivery. At the same time, mucus, mucociliary clearance, macrophage uptake and altered anatomy in diseased lungs present important barriers to effective pulmonary delivery.

Nano-enabled diagnostics exploit nanostructured materials to capture and amplify biological signals, potentially enabling faster, more sensitive and point-of-care detection. Gold nanoparticle-based lateral-flow assays are already widely used in respiratory infections, while nanostructured electronic-nose platforms analysing exhaled volatile organic compounds represent a promising approach to non-invasive disease detection.

Nanotechnology has also established a clear therapeutic role. Liposomal amikacin for refractory Mycobacterium avium complex lung disease demonstrates how nanocarriers can enhance local pulmonary drug delivery while limiting systemic exposure. Albumin-bound paclitaxel provides another clinically established nanoparticle platform in lung cancer, while lipid nanoparticles enabling mRNA delivery became one of the most widely deployed applications of nanomedicine through COVID-19 vaccines.

The next generation of respiratory nanomedicine includes nano-biosensors for tuberculosis, cell-targeted drug delivery in pulmonary fibrosis, inhaled RNA and gene therapies, and nano-enabled mucosal vaccines. However, most remain preclinical or early translational technologies. Biocompatibility, chronic pulmonary toxicity, reproducible formulation, aerosol stability, manufacturing scalability and regulatory requirements remain major barriers to clinical translation.

Nanotechnology should therefore be viewed not as an end in itself, but as a platform capable of sensing, carrying, targeting and releasing therapeutic or diagnostic payloads. Several applications are already part of contemporary respiratory practice, while others remain promising but unproven. The future is likely to be increasingly targeted and patient-specific, but clinical evidence must continue to lead technological enthusiasm.



Prof. Ashok Kumar Dasmahapatra

Indian Institute of Technology Guwahati, Guwahati, India

Ashok Kumar Dasmahapatra, Department of Chemical Engineering, Indian Institute of Technology Guwahati.

Computational Biophysics, Molecular Simulations, Polymer physics, Energy harvesting, conducting hydrogels for sensing, EMI shielding and energy storage applications.

Published over 50 research papers in international peer reviewed journals and 04 granted patents.

Disaggregation Of Alzheimer's Amyloid-β Fibrils – An All-atom Molecular Dynamics Simulation Study

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Department of Chemical Engineering, Indian Institute of Technology Guwahati, Guwahati – 781039, India

Abstract

Alzheimer's Disease (AD) is a progressive, neurodegenerative, geriatric and multi-faceted in nature with genetic, environmental and some unknown mechanism associated with it. Amyloid-β (Aβ) fibrils have been reported to be the principal clinical hallmark due to its direct involvement in the neurotoxicity and degeneration leading to AD. The therapeutic approaches have been broadly classified into (i) inhibition of the aggregation of the Aβ monomers and (ii) disaggregation of the preformed Aβ fibrils. The use of β-sheet breakers, nanoparticles, small molecules and natural compounds have been studied for the same purpose. The failure of the clearance of the drugs from inhibition strategy has motivated the in-depth investigations for the disaggregation approach. In this view the role of natural compounds has been preferred owing to their natural intoxicity and biocompatibility with the human system.

Various natural compounds from different category have been selected for the destabilization studies: caffeine from alkaloids; caffeic acid, gallic acid, epigallocatechin and ellagic acid from polyphenols; omega-3 polyunsaturated fatty acids (PUFAs) and lycopene from terpene. We have applied Molecular Dynamics (MD) simulation to study the destabilization potential along with the mechanistic details. In all the natural compounds, a general observation towards destabilization is drifting of the terminal chain from the fibril. Among all the polyphenols, ellagic acid (REF) has been found to be the best binder and destabilizer of Aβ fibril wherein it binds to chain A of the fibril by accessing fibrillar cavity.

The amphiphilic nature of the PUFAs was found to be the supportive for the better binding with the fibril, wherein polar head binds to the positively charged residues and long carbon tail to the hydrophobic residues of the fibril. The lycopene was found to interact with the surface and cavity of the fibril depending on the architecture of the fibril. From all the studies, the major governing principles behind destabilization of the fibril was observed by loss of H-bonds, breakage of salt-bridges, loss of hydrophobic interactions and loss of β-sheet content. A similar trend also has been observed with other small molecules as well as polypeptides. We have also observed that the destabilized structure does not refibril upon elimination of the ligand from the system. Thus, the present study successfully establishes the efficacy and prophecy in the destabilization of preformed Aβ fibril as a promising therapeutic approach for treating AD.

Keywords: Alzheimer's Disease, Amyloid-β (Aβ) fibrils, Destabilization, Molecular Dynamics Simulations, Protein-ligand interaction, Refibrillation



Dr. Arindam Banerjee

LifeSenz Cancer Research Labs Pvt Ltd.

Dr Banerjee is currently serving as CEO and Director of LifeSenz Cancer Research Labs in Mumbai. As a profession, he is a translational cancer biologist with more than 20 years of experience across academia and industry, at various international and national levels. His work expertise includes translational cancer research and cross-functional team building and networking. He has contributed to multiple peer-reviewed scientific publications, including senior author publications such as in Breast Cancer Research, PLOS One, Journal of Biological Chemistry, and Cancer Research, and has received accolades at various international scientific meetings. Dr. Banerjee is also an expert in advanced in vitro and ex vivo cell modelling-based platform development in various disease therapeutics fields. Moreover, he has an extensive experience with scientific project management, academic tutoring, and international collaborations. Dr. Banerjee received his PhD in molecular medicine from the University of Auckland, New Zealand, and subsequently gained relevant work experience across various international locations, such as the UK, Singapore, New Zealand, and India.

In vitro / Ex vivo Development of Human-Relevant Disease Models to Functionally Characterise Nanomedicines

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Abstract

In general, the drug discovery and development process carries multiple validation stages and consumes enormous time and money. Moreover, the clinical success rate of these drugs remains very poor. Clinical toxicity and poor translation of preclinical to clinical findings are implicated as the major challenges of clinical trial success. New Approach Methodologies (NAMs) are being explored in recent times, and global regulatory bodies are also supporting the inclusion of experimental data to correlate and assist clinical decision-making options. This would further reduce translational gaps, accelerate drug discovery and development timelines, and reduce the overall cost of the drug development processes. In this regard, LifeSenz Labs explores the development of various clinically relevant in vitro/ex vivo disease models, such as cancer, diabetes, inflammatory, autoimmune, and neurodegenerative disorders, as well as skin, hair, and gut-based cosmo/nutraceutical models. These models are readily useful to both academic and biopharma industries as a tool to understand and screen molecules, including nanomedicines and develop new therapy strategies.



Prof. Avinash Sonawane

Department of Biosciences and Biomedical Engineering, IIT Indore

Prof. Avinash Sonawane is currently a Professor at the Department of Biosciences and Biomedical Engineering, IIT Indore, Humboldt Visiting Professor at Leibniz Lung Centre, Borstel, Germany, and Head, School of Innovation, IIT Indore. His major research and technological development interests are on tuberculosis and blood cancer, focusing on diagnostics, drug development, drug delivery, and understanding molecular and immunological mechanisms. He obtained Ph.D. from University of Marburg, Germany, followed by postdoctoral studies at University of Florida, Gainesville, USA, Max Planck Institute for Infection Biology, Berlin, and European Molecular Biology Laboratory (EMBL), Heidelburg, Germany. He is recipient of several prestigious international awards such as Alexander von Humboldt Fellow, EMBO fellow, Swiss National Science Fellow, Swedish Institute Fellow and JSPS Fellow. Prof. Sonawane have received P. A. Kurup Endowment Award, Major General Saheb Singh Sokhey award, Young Scientist award, SERB-TETRA award, National Bioentrepreneurship award, Best Technology Development award to name a few. He also served as Dean, International Relations at IIT Indore, DAAD Research Ambassador, Ambassador of Association Commonwealth Universities, and Steering Executive Council Member, Indo- Europe Heritage Network Association, and Member of several Task Force Committees of Govt.

of India. He has more than 90 publications, 4 patents granted and transferred two technologies on leukemia drug development to the Biopharma Company. In collaboration, his group has developed non-invasive tuberculosis diagnostic kit TB-RAP, which detects TB from saliva and tongue swabs. TB-RAP kit is under clinical validation in various hospitals.

Nanomaterials for the targeted delivery and stability of therapeutic agents

Prof. Avinash Sonawane

Department of Biosciences and Biomedical Engineering, IIT Indore

Abstract



Prof. Mohammad Azhar Aziz, PhD

Aligarh Muslim University, India

Interdisciplinary Nanotechnology Centre, Aligarh Muslim University (AMU), Aligarh, India; Founder Director, Cancer Nanomedicine Consortium, AMU.

Area of Specialization/Interest: Cancer biology and translational oncology, with emphasis on colorectal cancer, precision and personalized cancer medicine, multiomics (genomics, transcriptomics, proteomics, metabolomics and miRNA), biomarker discovery, alternative splicing, machine learning, and nanomedicine-enabled targeted therapy. Achievements/Awards/Special: Cancer researcher with approximately 20 years of post-PhD experience and international research experience in the USA, Saudi Arabia and India. Established a colorectal cancer research program at King Abdullah International Medical Research Center (KAIMRC), Saudi Arabia, and founded the Cancer Nanomedicine Consortium at AMU. Has authored/co-authored more than 50 publications and edited work on personalized and precision nanomedicine for cancer treatment. Recipient of international Best Researcher and Young Scientist recognitions; member/ambassadorial contributor to professional cancer research organizations.

Nanomedicine Approach to Restore the Function of a Novel Tumour Suppressor Gene

Mohammad Azhar Aziz[1,2], Swati Acharya[1]

[1]*Interdisciplinary Nanotechnology Centre,*
[2]*Cancer Nanomedicine Consortium, Faculty of Engg. & Tech., Aligarh Muslim University, Aligarh, U.P. India*

Abstract

Colorectal cancer (CRC) remains a global health burden, accounting for more than 2 million new cases and estimated 918,000 deaths worldwide in 2024. In India, CRC is among the leading cancers, ranking fourth in incidence, with substantial regional variation.

The development of CRC takes place through series of complex events which involves genomic alterations including copy-number changes, activation of oncogenes, and suppression of tumour suppressor genes. Although the mechanism is under investigation, the loss of 18q chromosome marks an important event in CRC.

We previously identified a novel tumour suppressor gene ATPase, Aminophospholipid Transporter, Class I, Type 8B, Member 1 (ATP8B1), located on chromosome 18q to be associated with CRC progression. Integrated genomic and transcriptomic analyses further supported ATP8B1 as a potential driver gene for functional investigation, while its reduced expression in tumour tissue suggests a possible tumour-suppressive role.

Restoration of ATP8B1 function therefore represents a potential therapeutic strategy and may provide new insights into CRC biology. However, effective restoration requires efficient, tumour-specific delivery systems. We are investigating ATP8B1 gene expression in Indian CRC clinical samples and develop an integrated nanomedicine-based strategy to restore its function. Candidate drugs were evaluated via computational screening for nanoparticle-mediated delivery in colorectal cancer (CRC) models. Inorganic nanoparticles are synthesized (chemically and biologically) and characterized. Their nanoscale properties provide a platform for drug conjugation and delivery, with the potential to improve cargo stability, facilitate cellular uptake and enhance the effective availability of selected compounds. This drug-nanoparticle formulation is expected to improve drug stability, enable controlled release, and facilitate targeted tumour delivery.

This multidisciplinary framework integrates molecular profiling, computational drug repurposing, and nanomedicine to explore ATP8B1 function restoration as a targeted therapeutic approach in CRC.



Prof. Biswadip Banerji

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Biswadip Banerji, Chief Scientist & HOD, Organic & Medicinal Chemistry Division (OMC) and Central Instrumentation Facility (CIF), CSIR-Indian Institute of Chemical Biology (IICB), Kolkata, India-700032

Area of Specialization/Interest: Synthetic Organic Chemistry, Chemical Biology, Medicinal Chemistry, Peptide Chemistry

Peptide Based Enamine Switches and Their Therapeutic Efficacies

Dr. Biswadip Banerji[1] and Subhankar Shee[1]

[1]*Organic & Medicinal Chemistry Division and Central Instrumentation Facility (CIF) Division; Indian Institute of Chemical Biology (CSIR-IICB), 4, Raja S. C. Mullick Road, Jadavpur, Kolkata-70032*

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Abstract

Peptide–drug conjugates (PDCs) represent an emerging class of anticancer therapeutics that combine the high target specificity of tumor-targeting peptides with the potent cytotoxicity of chemotherapeutic payloads, thereby offering the potential to enhance therapeutic efficacy while minimizing off-target toxicity. In the recent years, molecular switches have attracted considerable attention as versatile platforms for controlled drug delivery in response to stimuli such as pH, light etc, owing to their ability to undergo reversible and repeatable structural transformations. The distinct physicochemical characteristics of the cellular microenvironment in cancerous and normal cells, particularly differences in intracellular pH, can be exploited to trigger such configurational changes. The intracellular pH of tumor cell is generally more acidic than that of normal cells (approximately pH 7.4), making acid–base-responsive molecular switches promising candidates for cancer therapy. In the present study, we synthesized a series of novel pH-responsive, peptide-based enamines and investigated their acid–base-induced configurational switching (E/Z) using 1H NMR and 2D NMR spectroscopy, complemented by single-crystal X-ray crystallography. These pH-responsive molecular switches exhibited pronounced anticancer activity against breast cancer cells, presumably through DNA intercalation. All newly synthesized molecules displayed low-to-moderate cytotoxicity toward the MDA-MB-231 breast cancer cell line, as evaluated by the MTT assay. Notably, our study identified two lead molecules which exhibited low cytotoxicity toward normal cells while demonstrating sub-micromolar IC values and the highest antiproliferative potency against breast cancer cells.

Keywords: Peptides, Anticancer, DNA-intercalator, Molecular switch, Enamine



Dr. Badri Parshad

Massachusetts General Hospital -
Harvard Medical School, USA

Badri Parshad received his MSc in Chemistry from Kurukshetra University and his PhD from the University of Delhi in 2018, where his research focused on amphiphilic and polymeric drug delivery nanocarriers. During his doctoral studies, he was awarded the prestigious ERASMUS+ fellowship to conduct research at Freie Universität Berlin where he continued his postdoctoral research until 2019, working in the area of pathogen inhibitors. In 2019, he moved to University of Cambridge UK, and in 2022 he joined Massachusetts General Hospital, Harvard Medical School, USA, where he continues to advance research on functional nanomaterials and photoimmunoconjugates for translational biomedical applications. He is recipient of the prestigious MarieCurie Postdoctoral Fellowship and the Ramanujan Fellowship. He holds one international patent and has authored four book chapters and over 35 peer-reviewed publications in leading journals, including Science Advances, Angewandte Chemie, ACS Nano, Nano Letters, Small, Advanced Science, and Bioactive Materials. His research interests include organic and polymer chemistry, antibody conjugates, drug delivery nanocarriers, and the development of multivalent inhibitors for pathogens. His work aims to bridge fundamental chemistry with practical biomedical applications, particularly in targeted therapy and infectious disease intervention.

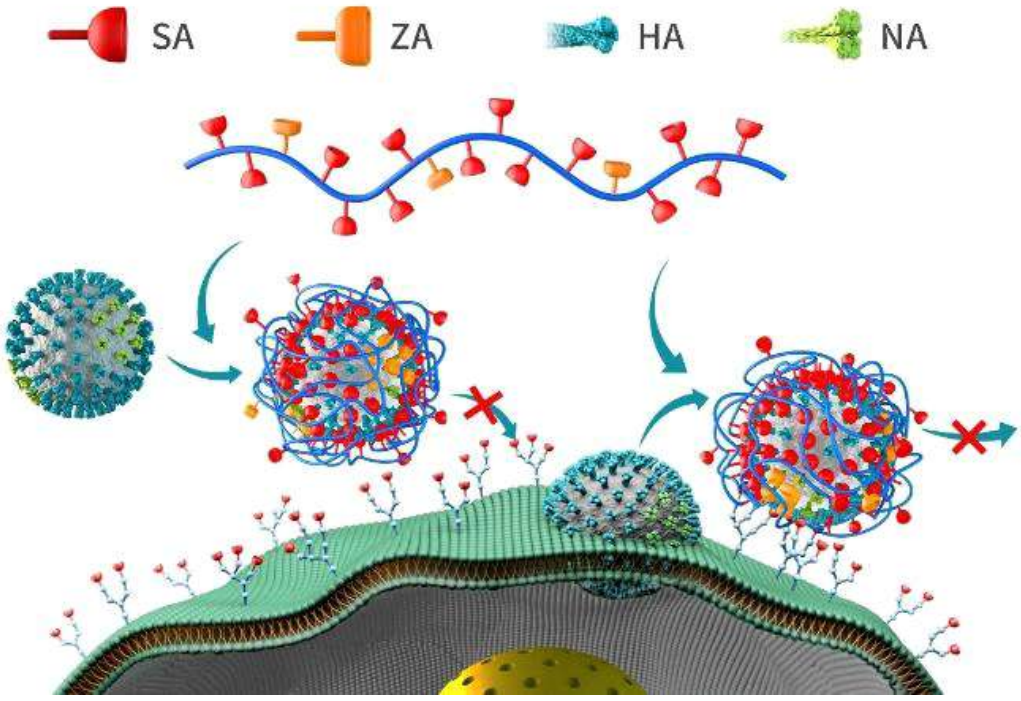
Heteromultivalent Architectures for Influenza Virus Inhibition

Badri Parshad, Marlena N. Schlecht, and Sumati Bhatia

Massachusetts General Hospital - Harvard Medical School, USA

Abstract

Influenza therapeutics with broad-spectrum activity and high efficacy are needed to fight emerging viruses, constantly mutating strains, and impending pandemics. An efficient strategy to inhibit influenza replication is to target both its surface proteins i.e. hemagglutinin (HA) and neuraminidase (NA), thereby inhibiting infection by preventing viral adhesion and release from the cell surface. In this study, we discuss the successful design and development of potent inhibitors of influenza A viruses prepared by the multivalent covalent attachment of sialic acid (SA)/sialyllactose (SL) and the commercial drug zanamivir (ZA) to various polymeric or nanoparticle surfaces. We demonstrate that by the optimum multivalent presentation of targeting ligands on a suitable backbone, viral infection is significantly reduced. These multivalent inhibitors achieve more than 99% inhibition. These findings both rationalize the efficient antiinfluenza efficacy of multivalent inhibitors and demonstrate that attaching both HA and NA inhibitors to the same backbone confers a cumulative mechanism of antiviral action potentially useful for inhibiting the virus even post-infection.





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Area of Specialization/Interest: Structural DNA Nanotechnology for Therapeutics and Nanomedicine

Achievements, Awards & Special Recognition:

- Ramanujan Fellowship
- Merck Young Scientist Award
- INYAS–INSA Membership
- Outstanding Faculty Award, IIT Gandhinagar
- Recipient of multiple national and international grants and fellowships
- Founder/associated with startup company Qnanosol Biotech Pvt. Ltd.

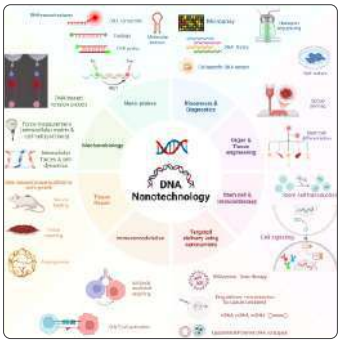
DNA Based Nanodevices for Targeted Applications in Nanomedicine and Therapeutics

Dhiraj Bhatia

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Abstract

My laboratory ask how nanometer-sized biomolecules transmit and integrate information across much larger length scales of the orders of cells and tissues. We seek to explore how collections of macromolecules work together to establish a common functional system like cellular pathways, organelles, living cells and further into tissues, organs and entire organisms. Different biomolecules establish long-range orders in living systems by self-assembling into much larger structures, such as molecular complexes, membranes, and cytoskeletal organelles, intra- and inter-cellular contacts, and long range contacts. The main theme of our lab will be understand the assembly principles of biological systems and the roles they play in living cells, tissues and full organisms...and further developing technologies to modulate the same. To address these problems, we adapt multidisciplinary, bottom-up approach using DNA nanotechnology. DNA has immense potential to arrange the matter at nanoscale with extreme robustness and spatial specificity. The compatibility of DNA to interface with other biomolecules like proteins, carbohydrates, lipids, small molecules make DNA a natural choice of material for bottom-up self-assembly. Thus, we will merge the complex programmability of DNA nanotechnology with the structural and functional diversity of other biomolecules. Our interdisciplinary research, along with national and international collaborations with experts, will leverage expertise from chemistry, nanotechnology, biophysics, biology, engineering, and medicine. The overarching goal of the my team would be to translate laboratory findings into the development of new therapeutic strategies.



Keywords: Structural DNA nanotechnology, Biofilms and Hydrogels Biomedical and translational applications.

Key Publications"

[1] Geometry of DNA nanostructures influences its endocytosis: Cellular study on 2D, 3D and in-vivo systems. Anjali Rajwar and Dhiraj Bhatia* et al (* Corresponding author), ACS Nano 2022, 16, 7, 10496–10508
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Dr. Gorachand Dutta is an Assistant Professor Grade-I at the School of Medical Science and Technology, Indian Institute of Technology Kharagpur. His research focuses on biosensors, electrochemistry, nanotechnology, printed bioelectronics, microfluidics, and point-of-care diagnostic technologies. His work aims to develop simple, affordable, portable, and integrated biosensing platforms for healthcare applications, particularly for early-stage disease diagnosis.Dr. Dutta's research encompasses the development of lab-on-a-chip and lab-on-PCB devices, wash-free electrochemical immunosensors, nanomaterial-based biosensors, microfluidic systems, and self-powered bio-devices. His group works at the interface of biosensing, electrochemistry, electronics, biomedical engineering, and healthcare, with applications in the detection of cancer, infectious diseases, metabolic disorders, and other clinically relevant biomarkers.He has published extensively in international peer-reviewed journals and has been involved in several research projects supported by national funding agencies. His recent work includes portable electrochemical sensors, point-of-care diagnostic devices, and non-invasive biomarker detection platforms. Dr. Dutta has also received several recognitions for his contributions to research and innovation in biomedical sensing and diagnostic technologies.

NanoBio Technology Enabled Electrochemical Sensor Devices for Onsite Applications

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Abstract

The evolution of point-of-care testing provides medical diagnosis within and outside the laboratory. Such bench-to-bedside diagnosis can advance patient management to a great extent. To cater to the needs, a significant amount of research and awareness programme have been conducted to come up with an inexpensive, accurate, sensitive point of care device at an affordable price to reach common people. Our cutting-edge research for the Rheumatoid Arthritis, Parkinson, Cervical Cancer, and environmental monitoring devices are fulfilling current needs for onsite application. We developed novel, portable, and user-friendly potentiometric sensor for non-invasive detection of salivary Na+ and K+, using specific nanoparticles-modified laser-induced graphene (LIG) electrodes providing highly sensitive response across physiologically relevant concentrations. Such a type of sensing system provides a practical and cost-effective solution for point-of-care electrolyte monitoring in human saliva. We also developed salivary urea quantification based on silver dendrite-modified LIG (Ag-LIG) electrochemical sensors which offers a noninvasive alternative to the commonly used blood urea nitrogen estimation for CKD diagnosis. This confers ease of detection to non-skilled personnel and is pertinent to public screening. Our carboxylic acid functionalized multiwalled carbon nanotubes (C-MWCNT) intertwined with coexisting phases of gadolinium monosulfide (GdS) and gadolinium oxide (Gd2O3) nanosheets is demonstrated splendid specificity for nonenzymatic electrochemical detection of uric acid (UA) in biological samples. This nonenzymatic electrochemical UA sensor is selective, sensitive, reproducible, and stable, making it reliable for point-of-care diagnostics.

We developed environmental Contaminants Monitoring Device “PENI-tron” for Sustainable Smart Agriculture in Soil, Food, and Water. The contamination of agricultural produce and water sources with pesticides and nitrate poses significant environmental and health challenges. We developed portable, cost-effective electrochemical sensors that can simultaneously detect multiple pesticide classes and nitratewith high sensitivity, stability, and reproducibility in onsite settings. Also for food quality monitoring, we developed aptamer based sensors for onsite easy application. The aptamer-functionalized bioelectrode (histidine-tagged streptavidin (HTS) onto Ni–NiO-modified electrodes) showed an excellent linear response (10–106 fg/mL) and an impressive detection limit of Patulin Mycotoxin (1.65 fg/mL, +3σ of blank signal) in Apple Juice . A portable electrochemical platform for biorecognition-free detection of ochratoxin A was developed for onsite use for food safety and quality monitoring using a paper-based electrode modified with tellurium oxide (TeO2) sheets and nickel oxide (NiO) nanoparticles [9]. This hand-held device presented the advances in smartphone-integrated, paper-based, low-cost electrochemical sensors for the rapid monitoring of the quality of food products.

As part of our community outreach activities and technology dissemination efforts, we successfully interacted with the end-users, farmers, emphasizing the importance of regular soil and water quality checks and educating them about the health hazards associated with different contamination.



Dr. Elena Nikolskaya

N.M. Emanuel Institute of Biochemical Physics RAS (IBCP RAS)

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Area of Specialization/Interest:
Synthesis of polymeric nanoparticles, biomimetic delivery systems, exosomes, and targeted delivery systems. Investigation of the physicochemical and biological properties of delivery systems in vitro and in vivo.

Achievements/Awards/Special:

1) Head of the Master's program "Neuroengineering and Theranostics" (field of study 19.04.01 "Biotechnology"); program webpage: https://misis.ru/applicants/admission/magistracy/faculties/biotech/theranostics/
2) Head of Laboratory in N.M. Emanuel Institute of Biochemical Physics RAS (IBCPRAS)
3) Member of the «Kolba» project expert council https://kolba-win.ru/
4) Member of the Academic Council of the Institute of Biochemical Physics of the Russian Academy of Sciences (IBCP RAS)
5) Administrator, creator, and owner of the Russian chat community for nanotechnology specialists ("Nano by Nano" https://t.me/+nnGh3fKmrmxjNTQ6)
6) Recipient of the N. N. Semenov Scholarship for Young Scientists (2019 and 2020)

Polymeric Nanoparticles For Biomedical Applications: Design, Biological Properties, and Therapeutic Efficacy in Cancer Treatment

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Abstract

Biodegradable polymers have been among the most intensively studied materials in recent years due to their potential use as artificial scaffolds for tissue engineering and drug delivery systems. Nanoparticles must be biocompatible and biodegradable. The use of drug delivery systems based on medical polymers, approved by regulatory agencies in various countries, can significantly improve the efficacy of many drugs by preventing their premature metabolism, reducing drug interactions with unwanted targets by modifying accumulation mechanisms, and optimizing drug release rates. Poly(lactic-co-glycolic acid) (PLGA)-based nanoparticles are widely used as drug delivery systems. PLGA nanoparticles represent a promising approach to developing new drug delivery systems for cancer treatment.

The development of a method for producing nanoparticles based on PLGA and polyethyleneglycol-modified PLGA (PLGA-PEG) with co-encapsulation of a cytotoxic drug (doxorubicin, DOX) and a histone deacetylase inhibitor (vorinostat, SAHA) for effective breast cancer therapy is one of the promising areas.

We use Box-Behnken designs to develop and optimize polymer nanoparticle synthesis technology. This approach allows us to conduct a minimal number of experiments and accurately predict the optimal parameters for synthesizing nanoparticles with given parameters. We have developed a method for the production of NPs with the co-encapsulation of the above-mentioned drugs in the ratio that gives the strongest synergistic effect (1:30, DOX:SAHA) - NP-SAHA/DOX. Experimental data revealed that optimized conditions provided the NPs with a size of 211 nm, PDI of 0.111, zeta potential of -25.4 mV and DOX/SAHA drug loading of 1.75 and 0.13%, respectively. Transmission electron microscopy was used to study the morphology of the obtained NPs.

The ability of NPs with co-encapsulated drugs to inhibit cell growth was demonstrated in 2D and 3D models of human breast cancer cell lines MCF-7, MCF-7/ADR, SKBR-3 and MDA-MB-231 using the MTT assay. The results demonstrated that NP-SAHA/DOX exhibited a notable synergistic effect against MCF-7 cells. We revealed a low combination index (CI) value for NP combination on MCF-7 cells, indicating a pronounced synergistic effect of combination. In the case of MCF-7/ADR cells, the observed CI values were close to 1, indicating an additive effect. For MDA-MB-231 cells, along with MCF-7, we selected the one of the lowest CI values to achieve the synergistic effect from the combined addition of SAHA and DOX into NP. However, the desired result was not obtained in a triple-negative breast cancer cell line, which may be attributed to the high heterogeneity of MDA-MB-231 tumor cells. Therefore, we identified MCF-7 cells as the most NP-sensitive one, and MDA-MB-231 cells as models for further NP-SAHA/DOX studies to achieve a synergistic effect from the combined administration of SAHA and DOX into NP. We have shown that co-encapsulation of SAHA and DOX in polymeric particles enhances cytotoxic activity of the drugs in both 2D and 3D breast cancer cell lines cultures.

To study the effectiveness of cellular internalization and distribution of NPs laser scanning confocal microscopy was used. We observed a comparable distribution profile of DOX and NP-DOX on MDA-MB-231 cells. Following a 24 h incubation, DOX and NP-SAHA/DOX demonstrated a more pronounced accumulation in MDA-MB-231 cells compared to that observed after 1 h.

Antitumor efficacy was studied in the MDA-MB-231 human mammary adenocarcinoma model inoculated into BALB/c immunodeficient nude mice. DOX-SAHA-NP showed the most pronounced antitumor efficacy - the tumor volume was significantly different from the control group on days 26, 29 and 33, and significantly different from the group receiving a mixture of substances on day 33. The biodistribution of DOX-SAHA-Cy5.5-NP was studied in BALB/c nude mice inoculated with the human mammary adenocarcinoma line MDA-MB-231. The most pronounced accumulation was observed in the spleen, liver and tumor tissue.

Co-encapsulation of DOX and SAHA in PLGA-PEG nanoparticles is a promising strategy for the treatment of breast cancer, as it combines the advantages of combination therapy with two drugs whose mechanisms of action target cell cycle dysregulation through different pathways and an improved safety and efficacy profile due to the specificity of the system's action and reduced chemoresistance.

Keywords: Nanoparticles, PLGA, Drug Delivery Systems, Controlled Drug Release, Cancer

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Achievements/Awards/Special:
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She has led and coordinated several national research programmes, including the ICMR Task Force on Nanomedicine and the National Registry for Venous Thromboembolic Disorders (I-RegVeD). She has contributed to the ICMR Validation Framework for Indigenous Diagnostic Kits for Sickle Cell Disease and led the National Health Research Priority-setting exercise for Sickle Cell Disease. She is also involved in the NHRP projects, SAHAY and Bharat CARES, which aim to strengthen comprehensive sickle cell disease care in India, and serves as Project Coordinator for Bharat CARES.

Nanomedicine Research in India: ICMR's Perspective on Progress and the Road Ahead

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Abstract

Nanomedicine has the potential to transform healthcare through improved diagnostics, targeted drug delivery, better therapeutic approaches, and more personalized treatment. In India, interest in nanomedicine has grown considerably over the years, supported by increasing research activity and initiatives from national funding agencies. The Indian Council of Medical Research (ICMR) has contributed to this growth by supporting research across different areas of nanomedicine and by encouraging innovations that can address important healthcare needs. ICMR-supported research has covered a wide range of areas, including therapeutics, diagnostics, infectious diseases, drug-delivery systems, theranostics, and other emerging applications.

Experience from research proposals and projects received and supported by ICMR also provides an opportunity to understand how the nanomedicine landscape in India is evolving. While considerable progress has been made, particularly in therapeutic and cancer-related applications, there is a need to expand research into other areas of public health importance. More attention is also required to move promising technologies from laboratory research towards clinical application. Issues related to long-term safety, scalability, regulatory requirements, commercialization, and equitable research capacity across the country remain important considerations.

Going forward, the focus needs to extend beyond developing novel nanomaterials to demonstrating their safety, effectiveness, affordability, and relevance to healthcare needs. Stronger collaboration among researchers, clinicians, funding agencies, regulators, and industry can help bridge the gap between research and implementation. Emerging opportunities at the interface of nanomedicine with genomics, bioinformatics, and precision medicine may further expand its role in prevention, diagnosis, and treatment.

ICMR's experience highlights both the growing strength of nanomedicine research in India and the need for a stronger pathway from research to translation and ultimately to public health impact. Continued support for innovative, interdisciplinary, safe, and clinically relevant research can help nanomedicine contribute meaningfully to the future of healthcare in India.

Keywords: Nanomedicine; ICMR; India; Research and Innovation; Clinical Translation; Public Health



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Dr. Lyubov V. Yurina is a researcher at the N.M. Emanuel Institute of Biochemical Physics, Russian Academy of Sciences, Moscow, Russia. She holds a Ph.D. in Biophysics and has been actively involved in interdisciplinary research at the interface of biophysics, biochemistry, proteomics, and biosensor technology. Her research interests include oxidative modification of proteins, protein structure–function relationships, haemostasis, proteomics, and the development of immunochemical and surface-enhanced Raman scattering (SERS)-based methods for the detection of biological markers. Dr. Yurina has contributed to research on the effects of oxidative stress on plasma proteins, including fibrinogen, plasminogen, and coagulation factor XIII, using advanced biochemical and analytical techniques. Her recent work also includes the development of SERS-based biosensing approaches for sensitive detection of biomolecules and disease-related markers. She has published her research in international peer-reviewed journals and continues to pursue multidisciplinary research in biomedical analysis, protein biophysics, and biosensor technologies.

Surface-enhanced Raman Spectral Features Enrichment By Selective Protein Enzymatic Digestion: A New Approach For PTM Search

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Abstract

This study explores the enrichment of surface-enhanced Raman spectra through selective peptide bond hydrolysis, using fibrinogen oxidation by hypochlorite as a case study. The enzymatic cleavage of the protein enables the identification of specific vibrational bands related to methionine and tryptophan oxidation. Confirmed by HPLC-MS/MS, these findings suggest that the proposed method offers a powerful new perspective for researching oxidative modifications in proteins.

While tandem mass spectrometry (HPLC-MS/MS) is currently the standard for analyzing protein covalent modifications, SERS spectroscopy offers a promising alternative by providing vibrational spectrum of amino acid residues of polypeptide chains. A major limitation of SERS for intact proteins is their large size and complex conformation, which leads to a random orientation on the metal surface and low analyte concentration in 'hot spots.'

To overcome this, we propose using enzymatic hydrolysis to break proteins into short peptides (up to 30 amino acid residues). This allows for a higher density of molecules within the nanostructures' active zones, enhancing spectral detail. This approach was validated by analyzing and comparing both native and hypochlorite-oxidized fibrinogen (FG).

According to the results of HPLC-MS/MS, the action of the oxidant on the FG molecule resulted in the oxidation of side chains of the residues, to a higher extent, of methionine and tryptophan (19 and 6 modified residues, respectively) among which the following types of oxidative modifications were detected: formation of methionine sulfoxide due to the addition of one oxygen atom to the side chain (+15.99) with the possible further addition of one more oxygen atom (+31.99) resulting in methionine sulfone or detachment of methanethiol from the side chain of methionine sulfoxide (−48.00) and oxidation of tryptophan to 2-hydroxytryptophan or oxindolalanine (+15.99) and N´-formylkynurenine (+31.99). Then the sensitivity to oxidation decreases in the order Lys ≥ Tyr > Asp.

An analysis of the SER spectra of the FG groups after selective enzymatic hydrolysis shows an increase in the number of significant bands in the SER spectra due to the appearance or more pronounced character of vibrational bands in the following ranges: at 417—453 cm^{-1} with peaks at 420 and 426 cm^{-1}, which are assigned to the bending vibration of the indole core of tryptophan; at 750—796 cm^{-1} with peaks at 756 and 758 cm^{-1} attributed to the "breathing mode" of Phe and Trp, and a band at 767 cm^{-1} corresponding to the out-of-plane C—H bending vibration (inflection) of histidine; at 1058—1108 cm^{-1} with the C—N stretching bands of Val, Gly, Ala, Ser, Leu, and Ile residues, and at 1447—1457 cm^{-1} (in the range of manifestation of CH/CH3 bending vibrations of the Phe, Trp, Met, Cys, and Gln residues). The high variability of the spectra of the FGp-c sample as compared to that of FGp-o can be explained by the presence of both modified and unmodified residues in the analyzed native hydrolyzed FG (according to the HPLC-MS/MS data, the fraction of the observed modified methionine and tryptophan residues ranges from 1 to 25%). In turn, the fraction of modified residues in the peptides increases strongly upon the treatment of FG with the oxidant, and the HPLC-MS/MS data show that the fraction of the found modified methionine and tryptophan residues ranges from 80 to 100%, which can result in a decrease in the variability of the obtained spectra.

Importantly the averaged spectra of the peptides of oxidized and non-oxidized FG appreciably differ in several spectral regions. The spectrum of oxidized FG peptides exhibits a decrease in the intensity of bands at 420 and 758 cm^{-1}, as well as in ranges of 1058—1108 and 1468—1478 cm^{-1} containing bands of easily oxidizable residues and in the amide I range (1645—1680 cm^{-1}). However, the spectrum of oxidized FG peptides contains new or more pronounced bands attributed, most likely, to the oxidation products methionine sulfoxide (stretching vibrations at 702 (ν(C—S)), 945 (ν(C—S=O)), 1008 cm^{-1} (ν(S=O))) and methionine sulfone (at 1134 cm^{-1} (ν(S=O))), which are the oxidation products of the side chain of methionine residues, and to 2-hydroxytryptophan (492 cm^{-1}) and N'-formylkynurenine (542 and 1455 cm^{-1}), being the oxidation products of tryptophan residues. In addition, the spectrum of oxidized FG peptides shows a substantial increase in the intensity of the bands in a range of the tyrosine doublet (830—860 cm^{-1}), to a higher extent at 860 cm^{-1}. All the listed types of the modified amino acid residues were detected in the FG samples also by the HPLC-MS/MS method.

The preliminary enzymatic hydrolysis of samples of native and oxidant-treated FG results in the features enrichment of the SER spectra, which makes it possible to distinguish the vibrational bands assigned to the major oxidation products of the residue side chains (methionine sulfoxide, methionine sulfone, 2-hydroxytryptophane, and N´-formylkynurenine) and makes the proposed approach applicable to the study of the oxidative modification of proteins.

Keywords: surface-enhanced Raman spectroscopy, fibrinogen, oxidative modification, HPLC-MS/MS, selective hydrolysis

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Prof. Monalisa Mukherjee is an accomplished academic and researcher, currently serving as the Director of the Amity Institute of Click Chemistry Research and Studies (AICCRS) and Professor at the Amity Institute of Biotechnology, Amity University, Noida, India. She obtained her Bachelor's and master's degrees in chemistry from the University of North Bengal, India, and earned her Ph.D. in Biomedical Engineering from the Center for Biomedical Engineering, IIT Delhi in 2006. She is a recipient of several prestigious accolades, including the National Scholarship Award (1998), Young Scientist Award (2010), and the UK-India Distinguished Visiting Scientist Award (2011). In recognition of her significant contributions to chemical sciences, she was elected as a Fellow of the Royal Society of Chemistry (FRSC), London, UK, in 2021. Over the past five years, she has made pioneering contributions to the field of Materiobiology. Her work is well-recognized both nationally and internationally, with publications in numerous journals of repute such as Journal of the American Chemical Society, ACS Nano, Nano Today, Materials Horizons, ACS Applied Materials & Interfaces, ACS Sustainable Chemistry, ACS Applied Polymer Materials, Biomaterials Science, Journal of Materials Chemistry A & B, Biomaterials Advances, and Green Chemistry. Her research portfolio also includes multiple patents and a strong translational focus. A landmark in her scientific journey was the discovery of ice helix structures locked within crystalline, hexagonally packed hydrogel nanotubes, inspired by the ancient art of origami. This breakthrough, published in Materials Horizons (2019), was featured on the front cover of the journal and included in the Horizons Community Board Themed Collection – Nanobiomedicine. The work received widespread attention and was highlighted in both - The Hindu newspaper and Science Chronicles. Demonstrating the translational impact of her research, Prof. Mukherjee recently initiated a collaboration between AICCRS and Industry focused on diabetic wound healing, leveraging her novel drug delivery formulations. This partnership, currently in its first phase, is expected to expand through an MOU between Industry and Amity University, aiming at future projects in novel drug discovery—a testament to the societal relevance and real-world applicability of her innovations. To date, she has successfully completed 10 research projects and is currently leading 3 ongoing projects. She has supervised 11 Ph.D. scholars and mentored 20 M.Tech students in their dissertation work. Prof. Mukherjee is an Editorial Board Member in the Chemistry and Chemical Biology Division of Scientific Reports (Nature Publishing Group) and the Taylor & Francis journal Biocatalysis and Biotransformation. She has also served as a Research Task Force Member for the Chemical Science Domain of DST-FIST. In recognition of her academic stature, the Executive Council of Telangana University conferred upon her the title of Honorary Professor. In addition to this Prof. Mukherjee has edited 2 books entitled “Bioinspired and Green Synthesis of Nanostructures: A Sustainable Approach” Published by Wiley and “Fundamentals of translational Tissue Enginerring” published by Elsevier and continues to advance the frontiers of science through interdisciplinary research, industry collaboration, and dedicated mentorship.

Click-Engineered Carbon Dots Remodel the Inflammatory Microenvironment to Accelerate Healing of Infected Diabetic Wounds

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Abstract

Chronic diabetic wounds remain a formidable clinical challenge due to persistent bacterial infection and a dysregulated inflammatory microenvironment that disrupts normal wound healing. Prolonged inflammation impairs re-epithelialization, granulation tissue formation, and neovascularization, resulting in a persistent cycle of infection, inflammation, and tissue damage. Herein, we report a click-engineered carbon-dot nanoplatform designed to simultaneously target infection and inflammation in non-diabetic, diabetic, and infected diabetic wound models.

Pristine carbon dots (Pn-CDs) were synthesized via hydrothermal carbonization and subsequently functionalized through Cu(I)-catalyzed azide–alkyne cycloaddition (CuAAC) to generate triazole-functionalized carbon dots (Tz-CDs). Structural and spectroscopic analyses confirmed successful incorporation of 1,2,3-triazole moieties onto the carbon-dot surface while preserving the nanoscale carbon core. The chemically robust triazole scaffold enhanced interfacial interactions with biological targets, contributing to improved therapeutic activity.

Tz-CDs exhibited potent antibacterial activity against methicillin-resistant Staphylococcus aureus (MRSA), achieving a 2-fold reduction in MIC to 62.5 μg mL^{-1}. Importantly, Tz-CDs also modulated inflammatory cytokine expression, restored immune homeostasis, and enhanced angiogenic signaling, promoting tissue regeneration and preservation of wound architecture. Overall, Tz-CDs represent promising multifunctional nanotherapeutics for chronic infected diabetic wound management.



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Prof. Nidhi Chauhan is a Professor at the School of Health Sciences and Technology, UPES, Dehradun, India. She is a distinguished researcher specializing in nanobiotechnology, biosensors, nanotechnology, biochemistry, and biomedical devices. Her research focuses on developing innovative and affordable technologies for healthcare and diagnostic applications, with an emphasis on translating nanotechnology-based research into practical solutions.Prof. Chauhan has extensive research and teaching experience and has published more than 125 research papers in reputed international journals. She actively mentors Ph.D. scholars and postgraduate students and contributes to multidisciplinary research at the interface of bioscience, nanotechnology, and biomedical sciences.She has received several prestigious honours, including the ICMR-DHR International Fellowship, SERB International Research Experience Fellowship, Shakuntala Amir Chand Award, and the Best Scientist Medal from the International Association of Advanced Materials. She has also been recognized among the top 2% of scientists worldwide and has received a Golden Letter of Appreciation from Nobel Laureate Prof. Barry J. Marshall.Her work reflects a strong commitment to advancing biosensor technologies, nanomedicine, and accessible healthcare solutions.

Isolation and Assessment of fungi derived from wastewater for sustainable energy generation

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Abstract

Urbanization has intensified the demand for different sustainable energy-generating solutions. One promising approach is the treatment of wastewater using electrochemical setups. A microbial fuel cell (MFC), an electrochemical setup, can be highly effective for wastewater treatment as it simultaneously generates bioelectricity. This study focuses on the isolation, characterization, and evaluation of electrogenic fungal species from wastewater samples (WWS) collected from the Uttarakhand region. Using the potentiostat, an electrochemical workstation, we screened a total of 70 different fungal isolates and identified 10 distinct fungal strains as potent current generators. Morphological characterization of these strains revealed several fungal structures, including hyphae and spores. The most potent fungi were further analyzed based on Polymerase Chain Reaction (PCR) amplification and genomic sequencing of the internal transcribed spacer (ITS) region. The obtained sequences were subjected to Basic Local Alignment Search Tool (BLAST) analysis, and the corresponding fungal isolates were assigned genus names after comparison with representative sequences available in GeneBank. ITS sequencing for the top three potent fungi revealed their highest resemblance to Aspergillus flavus (99.09%), Diaporthe caryae isolate KM 19 (96.18%), and Montagnula donacina (100.00%). Among these, the strain closely related to Aspergillus flavus demonstrated the highest current output. This isolate has been successfully submitted to the National Center for Biotechnology Information (NCBI) database under the accession number PX226319. The selected strain will be integrated into a dual-chambered microbial fuel cell (DC-MFC) system to evaluate its bioelectric performance under optimized conditions. Overall, this research established a foundation for identifying the potent fungal strains from local microbial communities present in wastewater for sustainable energy production.

Keywords: microgens; electrogens; wastewater; myco electrogenic; MFC



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Achievements/Awards/Special: PhD in Physics

Determination Of Cardiac Risks Based On Blood Serum Analysis Using Sers Spectroscopy And Machine Learning Methods

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Abstract

Surface-Enhanced Raman spectroscopy (SERS) can be used to detect enzymes and proteins in human blood plasma to assess the body's condition in various diseases [1]. Angiotensin-converting enzyme (ACE), produced by cardiac cells but not detectable by enzyme-linked immunoassay, can also be detected in this manner. Elevated cardiac ACE levels are known to signal cardiac risks (atrial fibrillation, myocardial infarction, coronary heart disease, etc.), and the ability to detect it would be useful for diagnostics.

The first stage of developing a method for diagnosing ACE from the heart using SERS spectroscopy required demonstrating the possibility of classifying ACE produced by different cells in the body. For this purpose, ACE from different tissues and fluids of the human body (heart, lungs, and seminal fluid) were isolated and purified to an electrophoretically homogeneous state, and their SERS spectra were obtained. Specialized SERS substrates were used for the measurements. The substrates were formed by electron-beam evaporation in a vacuum and represented self-organized nanostructured thin silver films [2]. The SERS spectra were measured using a Raman 300R+ confocal microscope-based Raman spectrometer at an excitation wavelength of 785 nm (Witec, Germany). Sixty-five spectra of each type of ACE were measured. The accumulation time of one spectrum was 60 sec, the number of averaging was 1, and the laser power was 54 mW.

To analyze the resulting spectral array of three types of ACE, a linear discriminant analysis model was used [3]. This model allowed us to obtain a representation of the spectrum in a space of lower dimensionality compared to the original one. It was shown that the spectra of different ACEs are effectively separable in this space. Using the classifier's linearity property, an assessment was made of the contributions of spectral features to the separation of different types of ACE, and spectral intervals with their maximum values were determined, and their assignment was also carried out.

The next step was to determine the optimal method for quantifying ACE from heart. An experiment was carried out to quantify ACE from the heart in model serum containing albumin supplemented with heart ACE at concentrations ranging from 10-7 M to 10-11 M at a total protein concentration of 1 g/L, which corresponds to the probable range of ACE values from normal and above. The SERS spectral arrays for each concentration, obtained from dried droplet sediments with a volume of 5 μL, were analyzed using the support vector machine, where the common logarithm of the ACE concentration was selected as the predicted variable. The resulting calibration curves demonstrated the applicability of the method for quantifying ACE from different sources in blood plasma, since the control points are located within the double range of the standard deviation.

To qualitatively determine ACE in real blood serum, the serum of healthy donors and patients with atrial fibrillation (7 healthy donors and 9 patients) were compared. The SERS spectral arrays were classified using a logistic regression model, with a resulting overall accuracy of 85 ± 10%.

Keywords: cardiac risks, surface- enhanced Raman scattering, machine learning methods



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Enhancing The Medicinal Potency Of High-value Himalayan Herb Colchicum Luteum By Forming Biogenic Silver Nanoparticles Based Nanobiomedicine: Antimicrobial, Anticancer And Antioxidant Evaluation

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Abstract

The goal of this study was to enhance the medicinal potency of the high-value Himalayan herb Colchicum luteum by synthesizing biogenic silver nanoparticles (CL-bAgNPs). The rapid increase in life-threatening diseases such as cancer, microbial infections and oxidative stress-related disorders represents a global health concern. Natural remedies, such as herbs, have been used for centuries due to their therapeutic properties, but their low efficiency in targeted delivery and slow onset of action often reduces their therapeutic impact. A combination of herbs with nanotechnology-based approaches has gained attention because it increases the medicinal efficiency of herbs. In this study, Colchicum luteum, a high-value medicinal Himalayan herb, was utilized for the synthesis of CL-bAgNPs. The bioactive compounds present in Colchicum luteum acted as natural reducing and stabilizing agents and facilitated the eco-friendly synthesis of CL-bAgNPs. Various experimental parameters were optimized to achieve maximum yield and stability of CL-bAgNPs. UV-visible spectrum revealed a distinct surface plasmon resonance peak at 425 nm, which confirms that CL-bAgNPs had been photo-fabricated using Colchicum luteum extract. Scanning electron microscopy and transmission electron microscopy revealed spherical morphology and size between 5-40nm, zeta potential was −24.2 mV, indicating stability, and energy-dispersive X-ray spectroscopy confirmed elemental composition of the prepared CL-bAgNPs. To confirm enhancement in medicinal potency of Colchicum luteum, both CL-bAgNPs and extract of Colchicum luteum were tested against microbial pathogens (bacterial and fungal) and found that CL-bAgNPs exhibited stronger antimicrobial effects, significantly outperforming the plant extract. Additionally, the DPPH assay showed 80.19 ± 1.2% inhibition of free radicals using CL-bAgNPs, outperforming the plant extract in the antioxidant test. The anti-cancer activity of CL-bAgNPs was studied using the MTT assay, and it showed excellent results against the human breast and lung cancer cell lines. Finally, CL-bAgNPs demonstrated high biocompatibility, with almost 80% viability in normal cells at the highest tested concentration, indicating no significant cytotoxicity. Thus, the CL-bAgNPs not only enhance the therapeutic efficacy of Colchicum luteum but also represent a promising, eco-friendly nanobiomedicine with potential applications in antimicrobial, antioxidant and targeted anticancer treatment.

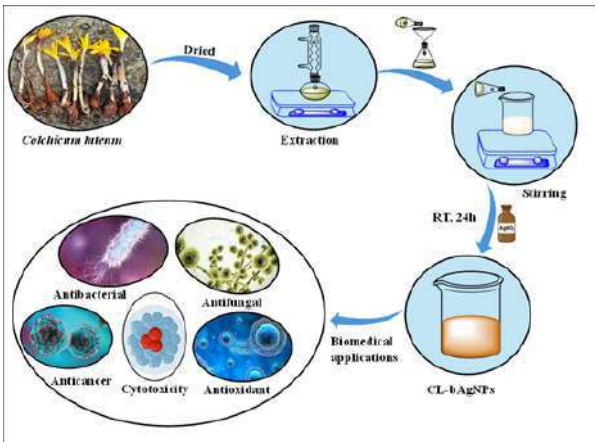


Fig. Schematic representation of preparation, characterization and applications of CL- bAgNPs.

Keywords: Himalayan herbs, Colchicum luteum, Biogenic silver nanoparticles, Nanobiomedicines, Anticancer activity, Antibacterial and Antifungal efficacy, Antioxidant assay



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Prof. Jyotsnendu Giri is a Professor in the Department of Biomedical Engineering at the Indian Institute of Technology Hyderabad (IIT Hyderabad), India.

Area of Specialization/Interest: His research focuses on nanomedicine, biomaterials, drug and biomolecule delivery, and regenerative medicine. He has made significant contributions to hybrid lipid nanocapsules for cancer therapeutics, protein/biomolecule stabilization and sustained delivery, microneedles, hydrogels, nanofibers, PRP-based regenerative therapies, wound and burn care, and tissue regeneration.

He received his Ph.D. in Nano-biotechnology from IIT Bombay and subsequently pursued postdoctoral research at the California Institute of Technology (Caltech), USA and NIST/NIH, as a National Academy of Sciences Research Associate Fellow (Recipient of National Research Council Fellowship, USA). He started his professional career as Jr. Group Leader at ADA Foundation–Paffenbarger Research Centre, USA, before joining IIT Hyderabad in 2013.

His recognitions include the Ramalingaswami Re-entry Fellowship, SERB Early Career Research Award, Abdul Kalam Technology Innovation National Fellowship, and IIT Hyderabad Research Excellence Award.

With a strong focus on bench-to-bedside translation and entrepreneurship, he co-founded EaffoCare Innovation Pvt. Ltd. and Kea Biotech Pvt. Ltd., translating academic innovations into affordable healthcare products.

Protein-based Microneedle-nanovaccine Platforms for Instant and Sustained Biomolecule Delivery Toward Cold-Chain-free Vaccination

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Abstract

Next-generation vaccination requires delivery systems that combine biomolecule stability, efficient immune activation, minimally invasive administration, and reduced dependence on trained personnel and cold-chain infrastructure. We developed protein-based microneedle platforms integrated with nanocarriers to enable rapid and sustained transdermal delivery of drugs and biomolecules, with particular emphasis on nucleic-acid vaccination and cancer immunotherapy. A hydrogel-forming microneedle platform was engineered to co-deliver a plasmid DNA vaccine encoding ovalbumin (OVA-pDNA) or OVA-protein antigen and the immunostimulatory adjuvant R848. Our developed CAPSules were used to complex OVA-pDNA through electrostatic interactions, achieving approximately 100% encapsulation efficiency at a 1:10 CAPSules:pDNA-OVA ratio. The resulting pCAPSules exhibited rapid endosomal escape within 30 min, supporting intracellular delivery of the antigen cargo. Incorporation of pCAPSules into protein-based hydrogel microneedles generated a mechanically robust VaxPatch with a mechanical strength of approximately 95 N and sustained nanovaccine release for more than 15 days at physiological pH. Importantly, pCAPSules released from VaxPatch after storage at different temperatures retained transfection activity, demonstrating the potential of the platform to enhance vaccine stability and reduce cold-chain dependence. In both prophylactic and therapeutic melanoma models, VaxPatch-mediated vaccination significantly suppressed tumour growth, enhanced CD4+ and CD8+ T-cell responses, and prolonged survival beyond 60 days. Together, these findings establish a versatile microneedle-nanomedicine strategy that integrates vaccine stabilization, controlled release, and immune activation within a single platform. By combining instant-dissolving and hydrogel-forming microneedle concepts, this approach can be extended to protein and nucleic-acid therapeutics and may provide a foundation for self-administrable, cold-chain-independent vaccination and nex

Keywords: Protein microneedles; Nanovaccine; Hydrogel; DNA vaccine; Cancer immunotherapy; Sustained delivery; Cold-chain-free vaccination



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Dr. Motilal Mathesh completed his PhD in 2016 and is currently a Senior Lecturer in the Master of Biotechnology program at Deakin University. He has been awarded prestigious fellowships and grants, including the Marie Skłodowska-Curie Actions and the Alfred Deakin Fellowship. His research lies at the interface of nanotechnology, biotechnology, and materials science, with a strong focus on the surface chemistry and functionalization of 2D nanomaterials for enzyme immobilization, the design of novel enzyme-powered nanomotors, and the development of smart biodegradable systems for biomedical applications. Dr. Mathesh has published more than 40 research articles in high-impact international journals in the fields of nanotechnology, materials science, and biotechnology.

Other Awards:

- SEBE Teaching Excellence Award,2025, Australia.
- IAAM Young Scientist Award, 2022, Sweden.

The Journey From Enzyme to Nanomotors: Engineering Smart Delivery Systems

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Abstract

Enzymes have evolved from simple biological catalysts into powerful building blocks for engineering dynamic, autonomous nanosystems capable of performing complex tasks within biological environments. This lecture will explore the evolution of enzyme-powered nano/micromotors, tracing the field from fundamental enzyme immobilisation strategies to the development of intelligent active nanomedicines. By integrating biotechnology, nanotechnology, materials science and nanoarchitectonics, the lecture will demonstrate how advances in enzyme engineering and functional nanomaterials have transformed conventional nanocarriers into self-propelled systems capable of chemotaxis, targeted transport and controlled therapeutic delivery.

The lecture will begin by highlighting the early research on enzyme immobilisation using graphene oxide a two-dimensional nanomaterial, where rational nanoarchitectonic design was employed to enhance enzyme loading, catalytic activity, stability and recyclability.[1, 2] These studies established highly efficient biohybrid catalytic platforms and demonstrated how two-dimensional materials could precisely organise enzymes at the nanoscale to improve catalytic performance. Building on these foundations, the lecture will show how these immobilisation strategies naturally evolved into the design of one of the first enzyme-powered two-dimensional nanomotor platforms, demonstrating autonomous propulsion and chemotactic behaviour and establishing a new class of active biomaterials.[3]

The lecture will then discuss how these design principles have expanded to a broader range of advanced nanoarchitectures, including metal-organic frameworks (MOFs)4 and hydrogen-bonded organic frameworks (HOFs),5-7 which provide highly ordered porous environments for enzyme immobilisation, catalytic confinement and substrate channelling. Together, these materials illustrate how nanoarchitectonics can be used to engineer multifunctional catalytic systems with enhanced biological functionality.

Building upon these material platforms, the lecture will provide an overview of the current state of enzyme-powered nanomotors, including recent advances in propulsion mechanisms, chemotactic navigation and biomedical applications. It will highlight pioneering studies demonstrating active transport across biological barriers and navigation through complex physiological environments, providing new opportunities for targeted drug delivery, intracellular transport, antibacterial therapy and precision cancer treatment. These studies offer important insights into how autonomous motion can overcome the transport limitations of conventional passive nanoparticles.

Finally, the lecture will discuss emerging opportunities for developing biodegradable and clinically translatable nanomotors based on polymers and naturally derived materials. By integrating lessons learned from enzyme immobilisation, nanoarchitectonic material design and active nanomotor engineering, these next-generation biodegradable systems have the potential to address key translational challenges while enabling safe, intelligent and clinically relevant nanomedicines.

Keywords: Nanomotors, 2D Materials, Organic Frameworks, Targeted Delivery, Biodegradable



Prof. Neetu Singh

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Prof. Neetu Singh, FBAO, Associate Fellow, INSA, received her Bachelor's and Master's degrees from the University of Mumbai and earned her Ph.D. in Chemistry from the Georgia Institute of Technology, Atlanta, USA. She subsequently completed her postdoctoral training at the Harvard-MIT Division of Health Sciences and Technology, MIT USA.

After returning to India, she joined the Centre for Biomedical Engineering (CBME), IIT Delhi, as an Assistant Professor in 2014 and is currently a Professor at the institute.

At IIT Delhi, she has established a multidisciplinary research program focused at the interface of nanomedicine, biomaterials, regenerative medicine, drug and gene delivery, cancer therapeutics, biosensing technologies, 3D vascularized disease models, and translational biomedical engineering. She has authored over 150 research publications and her work has significantly advanced the development of next-generation healthcare technologies. Prof. Singh's scientific contributions have been recognized through numerous prestigious national awards and honors including the Janaki Ammal National Women Bioscientist Award, NASI-Scopus Young Scientist Award, DBT Innovative Young Biotechnologist Award, IIT Delhi's early Career Research Award and the Bronze Medal of the Chemical Research Society of India. Internationally, she is India's representative at the International Union of Societies for Biomaterials Science and Engineering and serves on the Editorial Advisory Board of Bioconjugate Chemistry, In Vitro Models, Scientific Reports and is an editor at the Proceedings of INSA.

Prof. Singh is an Associate Fellow of the Indian National Science Academy (INSA), a Fellow of the Society for Biomaterials and Artificial Organs India (FBAO), and a SERB POWER Fellow.

Beyond her research accomplishments, Prof. Singh has played several important academic leadership roles at IIT Delhi and actively contributed to strengthening research, innovation, entrepreneurship, and interdisciplinary education in biomedical engineering. She has served as the Head of the Centre for Biomedical Engineering and the Professor In-Charge of UQ-IITD Academy of Research. Currently, she is leading the Wadhwani Innovation Center in Personalized Medicine and Healthcare at IIT Delhi.

Prof. Singh is also involved in technology translation and entrepreneurship. She has mentored the IIT Delhi-based startup Kriya Labs, which has developed sustainable technologies for the valorization of agricultural waste and circular economy applications. She is also the mentor of a diaognostic device startp BioElert Pvt. Ltd focusing on developing sepsis sensors for clinical applications.

Naturally derived vesicles based smart therapeutics for biomedical applications

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Abstract

Healthcare development has undergone exceptional improvements over the decade throughout the globe. Advanced drug delivery vehicles with properties such as lesser immunogenicity, stimuli-responsiveness, higher drug loading efficiency and optimal physico-chemical properties have been developed. But such vehicles are still not suitable for the delivery of highly potent hydrophobic drugs. Delivery of these drugs have posed significant challenges such as lesser loading efficiency, poor bioavailability and chemical instability. This has eventually restricted the clinical translation of highly potent hydrophobic drugs like Camptothecin (CPT). Due to the physico-chemical constraints and lack of delivery vehicles for the same, CPT's less potent derivatives are in clinical trials.

To overcome these issues, generation of nanoparticles either by formulating nanoparticles from host's own cells and loading them with drugs, or coating synthetic nanoparticles with cellular membrane and re-injecting these particles into individual's body have been developed. Nanoparticles from red blood cells referred to as nano-erythrosomes (NERs) have been the focus of research. The membrane proteins of NERs, including CD47, emit "don't-eat-me" signals that suppress macrophage phagocytosis. This property prevents their immediate immune clearance enhancing the circulation time of nanoparticles and providing elevated effect. Enhancing drug delivery vehicles further, synthesis of synthetic nanoparticles from polymers have been developed. These delivery vehicles have stimuli responsiveness and disease targeting properties which enhance drug delivery at target site. Encapsulation of these nanoparticles in NERs lead to the synthesis of nanoparticles having advanced effects. These involve stability, immune-evasiveness, high responsiveness and better loading efficiency of highly potent drugs.

These newer generation of smart nanoparticles have increased half-life in the bloodstream improving therapeutic effect. They have superior properties as compared to their counterparts. In this presentation, we have developed smart drug delivery systems through encapsulation of polymeric nanoparticles in NER membranes for delivery of Camptothecin (CPT), which is a potent topoisomerase inhibitor, a key enzyme involved in transcription. The objective of this work was to improve the drug loading efficiency of this highly potent hydrophobic drug, enhance the therapeutic efficacy of this drug and eventually increase the biocompatibility of multifunctional nanoparticles.

Keywords: Nanomedicine, drug delivery



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Prof. Nagendra Kaushik is an accomplished academician at Kwangwoon University, Seoul, where he has served for the past 16 years. He is also the President of the Indian Community Chamber (IIK). Renowned for his pioneering research in plasma bioscience, nanobiotechnology, and biomedical engineering, Prof. Kaushik has published over 300 scientific papers and holds multiple patent applications.

He is recognized as a Highly Cited Researcher by Kwangwoon University, placing him among the top 1% of academician in the university, and serves as honorary professor and advisor at several institutions and editor for more than 20 leading international journals. Prof. Kaushik has been listed among the World's Top 2% Scientists by Stanford University and Elsevier for last six consecutive years.

For his outstanding contributions, he has been honored with Honorary Citizenship by the Seoul Metropolitan Government, the Cabinet Ministerial Award 2025 at National Assembly of Korea (Korean Parliament), the prestigious Early Career Plasma Medicine Award 2020 from the International Society of Plasma Medicine (USA), Best Professor for Research Achievement Award 2026 and elected as a Fellow of the Royal Society of Chemistry (FRSC), UK. He has also been recognized as the “Sunlight of Korea” by the BRIC organization, along with several other awards for his high-impact scientific achievements.

Plasma Based Innovations in Bioscience and Nanotechnology

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Abstract

This talk's goal is to highlight some of the research behind non-thermal gas plasma techniques that are valuable for decontamination, microbial inactivation, viral sterilization, and other environmental implications. For a disease-free world, we are concentrating on industrial solutions to inactivate environmental pollutants such as microbes in soil, water, and air. Fundamental research on green and environmentally friendly methods for the synthesis of nanomaterials and their various biomedical applications is being done at our laboratory. In this area, we demonstrate a novel strategy using plasma-liquid interactions to enhance the green synthesis of metal nanoparticles. Additionally, facile upscaling of the production of these metallic nanoparticles is attainable using tricky green strategies. Through systematic adjustments in synthesis parameters, selection of appropriate biomaterial for the upscaling process, as well as the composition and structures of the nanoparticles, optimal conditions can be achieved to produce highly efficacious anticancer and antimicrobial metallic nanoparticles. These green approaches represent a cost-effective, environmentally conscious, and sustainable method for the fabrication of biocompatible hybrid nanoparticles with potential applications as therapeutic agents and industrial products.

Furthermore, the use of non-thermal plasmas extends beyond biomedical applications into the realm of material science and semiconductor technology. Plasma-based methods play a critical role in the development of advanced materials, enabling controlled surface modifications, thin-film deposition, and etching processes crucial for the semiconductor industry. Plasma treatment can improve the properties of materials such as enhanced conductivity, adhesion, and resistance to wear, which are essential in the fabrication of high-performance semiconductors. Additionally, plasma-assisted techniques are becoming indispensable in the fabrication of nanostructures that are increasingly important for the miniaturization of electronic devices and the enhancement of their functionality. Research in these areas is fostering innovative solutions for next-generation electronics, with plasma technology offering new pathways for creating efficient, scalable, and sustainable manufacturing processes in the semiconductor industry.

These green approaches, combined with plasma-based material science, represent a cost-effective, environmentally conscious, and sustainable method for the fabrication of biocompatible hybrid nanoparticles with potential applications across diverse sectors, including agriculture, bioscience, nanotechnology, environmental management, and semiconductor manufacturing.

Keywords: Plasma, Nanotechnology, Material Science, Pathogen, Cosmetics, Environment



Dr. Pradip Paik

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Prof. Pradip Paik, is B.Sc. (Chemistry Hons, Ramakrishna Mission, Narendrapur, CU), B. Tech. (Chemical Tech., CU), M.Tech. and Ph.D. from IIT Kanpur, a full Professor at the School of Biomedical Engineering, IIT (BHU) Varanasi. He is a pioneering inventor in translational nanomedicine and therapeutic technology. His work focuses on developing cost-effective, high-impact medical solutions, particularly for drug-resistant infections, cancer therapy, and chronic inflammatory diseases. He is a lead author of 36 patent applications and out of these 21 patent applications are already granted. He is also a lead author of 150 research articles Paik's research group has developed inorganic-based nanomedicines designed to tackle the global antimicrobial resistance (AMR) crisis. His group's patented inventions that specifically target and treat triple negative breast cancer (TNBC). Development of biocompatible polymer nanocapsules by his group can target tumor, which also acts as an adjuvant to stimulate the immune system and chemically modified nanoparticles loaded with siRNA and chemotherapy drugs that enhance stability and trigger cancer cell death through gene silencing. His group has developed mesoporous polymeric nanoparticles that treat acute inflammatory conditions like rheumatoid arthritis and neuroinflammation. This function similarly to aspirin but offer high therapeutic efficacy at much lower, immune-sensitive doses His group invented a polymer-based drug delivery system for malaria that includes a "time-temperature clock" module, allowing for the precisely tuned and sustained release of antimalarial drugs, is a sophisticated polymer-based nanomedicine. This allows for the precisely tuned release of antimalarial drugs, ensuring constant therapeutic levels in the bloodstream.

To bridge the gap between research and clinical application, Prof. Paik founded “Triphan Healthcare Pvt. Ltd.", a start-up focused on commercialising these breakthroughs to provide affordable healthcare to economically disadvantaged communities.

Dr. Paik is recipient of the awards: ISCA 'Young Scientist Award' (ISCA), Swarnaya Jayanty Endowment Fellowship (IIM), Associate Fellow (Telangana Academy of Science), Visiting Scientist/Faculty,-Israel; Research paper cash awards etc. Prof. Pradip Paik is also worked as a visiting faculty at the Department of Bioengineering, Rice University, Houston, Texas, USA. Paik's research group (Materials for Health care and Therapeutics Technology) is funded by IIT (BHU), I-DAPT, SERB, CRG, ICMR, DBT, DST, UGC, BHEL etc.. Currently Prof. Paik is a life member of many scientific communities, member of the editorial boards, etc.

Prof. Paik is presently serving as an Associate DEAN (Research and Development) and In-charge of Intellectual Property Right (IPR) along with the regular position in the School of Biomedical Engineering, IIT(BHU).

Novel polymeric nanomedicine for Neuroregeneration/protection, Tissue regeneration and Anti-inflammation

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Abstract

Amino acid-based block copolymer nanoparticles with cross-linkers have garnered growing interest in recent years. However, its' intricate synthesis and purification difficulties, along with stability concerns linked to inter-micellar crosslinking, restrict their potential use in healthcare and therapeutic applications. In this line, the present work is aimed to design amphiphilic block copolymer nanoparticles, with and without using a cross-linker via miniemulsion free radical polymerization. The self-assembled π-π stacking structural arrangement of copolymer at different temperatures has been confirmed through the molecular dynamics (MD) simulation, which corroborated the structural stability of copolymer nanoparticles at physiological temperature. The cell migration results polymeric nanoparticles are complementary to the CEMA assay and reveal their use in Nuroregeneration, Wound Healing, tissue regeneration and anti-inflammation. Further, the in vivo wound healing study demonstrated that within 13 days of post-treatment, the wound can be healed ~97%, whereas for the control, it is found to be only ~80%. Additionally, the RT-PCR results revealed that polymeric nanoparticles possess anti-inflammatory and tissue regeneration properties by down regulating TNF-α and IL-1β; and up regulating PECAM-1 and VEGF-A, respectively. In conclusion, novel nanoparticles are paramount with an extensive clinical potential for the regeneration of acute wounds and can be used for therapeutic applications and for the reduction of systemic inflammation.

Keywords: polymeric particles, amino acid, anti-inflammetion, neuroprotection, tissue regeneration, wound healing

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Dr. Pravin Shende is currently working as a Professor in NIPER, Mohali. He holds the Bachelor Degree in Pharmacy (2001), Master's Degree in Pharmaceutics (2005) and the title of Ph.D. in Pharmaceutical Sciences (2009). He has more than 19 years of teaching and research experience with post-doctoral research experience of 3 years at University of Torino, Italy.

His research areas include novel biosensors, controlled and sustained drug delivery systems, nanoparticulate delivery systems, transdermal drug delivery systems, biocarrier drug delivery systems, DoE-based formulation and development, targeted drug delivery systems, oncologic formulations, protein, peptide and DNA-based formulations. He has published more than 200 papers and articles in journals of repute. He has 6 granted Indian patents and 1 International. He has successfully completed 1 DST-SERB project funded by Govt. of India with 3 ongoing projects backed by various funding agencies such as AICTE, New Delhi; Rajiv Gandhi Science & Technology Commission, Govt. of Maharashtra and ICMR, New Delhi. Along with the government projects, he has successfully completed 2 industrial projects sponsored by national and international industries with effective tech-transfer.

He has guided more than 60 post graduate students successfully, with 5 candidates successfully completed the Ph.D.

Potential of nanotechnology-based devices in healthcare via pharmaceuticals

Prof. Pravin Keshaorao Shende

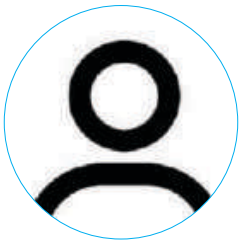
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Abstract

Nanotechnology in healthcare comprises nanodevices and nanomaterials, which have emerged for drug delivery, diagnostics, and theranostics applications. Nanodevices include microscale devices, microarrays, and intelligent machines. Polymer platforms include dendrimers, micelles, drug–polymer conjugates, nanogels, and protein-based nanoparticles, whereas non-polymeric systems encompass carbon nanotubes, nanodiamonds, metallic nanoparticles, quantum dots, and silica-based nanoparticles and lipid based which include liposomes, microneedles, and solid lipid nanoparticles. Asthma is a long-term respiratory disease involving airway inflammation and impaired airflow. There is a need for a noninvasive device to monitor asthma. Fractional exhaled nitric oxide is a clinically relevant biomarker of eosinophilic airway inflammation and can support the assessment of asthma. β-CD-based nanosponges-coated paper strip for asthma diagnosis is a biosensor nanodevice that monitors the fractional exhaled nitric oxide biomarker and offers advantages such as faster results integration with a smartphone app, cost-effectiveness, and suitability for personalized diagnostics. The optimized formulation exhibited a mean particle size of 679.51 ± 9.81 nm with a low polydispersity index of 0.225, indicating a relatively uniform particle-size distribution. The performance of the method is evaluated on healthy individuals compared with the FDA-approved NIOX MINO analyzer. The mean values obtained using NIOX MINO and the smartphone-based method were 25.4 ± 2.8 and 24.5 ± 3.2. This supports the potential of paper strips for asthma diagnosis. According to Bio-ADM data reported in 2019, the widespread use of commercially available pregnancy-test kits contributes substantially to plastic waste generation, with approximately 20 million kits sold annually. Nanotechnology-based bimetallic nanoprobe strips were prepared for detection of human chorionic gonadotropin in pregnancy. Gold and silver nanoparticles were independently synthesized via convention coefficient of R2=0.9796 with a sensitivity threshold of 0.79" ng/mL" and demonstrated 100% selectivity for hCG at concentrations ranging from 1.4 to 3 ng/mL, outperforming single metallic nanoparticles in accuracy and reproducibility. These innovations highlight the versatile scope of nanodevices in healthcare via pharmaceuticals. Development of a microneedle delivery system that encapsulates nanoparticles of nicotine and varenicline to provide a sustained release and effectively manage withdrawal symptoms associated with nicotine addiction, offering advantages such as dose reduction, decreased risk of engineered side effects, sustained drug delivery, and reduced withdrawal symptoms.

In vitro release studies demonstrated efficient delivery of both drugs, supported by precise microneedle morphology. Behavioural studies in mice confirmed the efficacy of the microneedle patch in alleviating withdrawal signs, anxiety, and hyperalgesia.



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Hematopoietic Stem Cells Cultured On Alginate-agarose Gels Exhibit Osteochondral Differentiation Abilities

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Abstract

Cell based therapies appear to be the best options in the treatment of insulted bone and cartilage, cells having their 3D architecture intact would be ideal in the regeneration of these tissues. In this scenario, the present study was aimed to explore the osteochondral differentiation abilities of human hematopoietic stem cells (HSCs) growing on alginate-agarose gels. Recently, we have shown the differentiation of human HSCs into articular type chondrocytes prominently expressing Indian hedgehog (Ihh), collagen II, and Aggrecan genes and such cells are vital in the manufacturing cartilage which is the primary step, it steadies and hardens the fracture callus for endochondral bone formation. Such cells growing on alginate-agarose gel which retains its 3D architecture would be ideal in the regeneration of injured cartilage and bone. To explain experimentally, pure human HSCs grown on alginate-agarose gels were differentiated to chondrocytes which were conspicuously expressing collagen II, Aggrecan and Ihh genes with high viability as assessed by MTT assay. Such growing chondrocytes were incubated with osteocyte differentiating medium which comprises of β-glycerophosphate, ascorbic acid, FGF and BMP-7 for 14 days. The oblong morphology chondrocytes differentiated into spindle shaped osteocytes on day 14. These cells showed positivity to alizarin red staining and noticeable alkaline phosphatase activity. Further, these cells showed prominent expression of RUNX2, Osterix, RANKL, SPARC, and Sclerostin genes, confirming formation of osteocytes from chondrocytes growing on alginate-agarose gels. All these findings clearly explain the osteochondral differentiation abilities of human HSCs growing on alginate-agarose gels and it elucidates the prominent role in the regeneration of insulted cartilage and bone.

Keywords: Human Hematopoietic stem cells, Chondrocytes, Articular cartilage, Trans-differentiation, Osteocytes



Prof. Raviraj Vankayala

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Dr. Raviraj Vankayala, Associate Professor, Department of Bioscience and Bioengineering, IIT Jodhpur; Head, MedTech Center, IIT Jodhpur.

Area of Specialization/Interest: Dr. Vankayala's research lies at the interface of nanobiotechnology, biomaterials, photomedicine, and precision healthcare, with a particular focus on engineering light-responsive nanoplatforms for disease diagnosis and therapy.

Achievements/Awards/Special: He received his Ph.D. in Chemistry from the National Tsing Hua University, Taiwan, and subsequently conducted postdoctoral research at National Tsing Hua University and the University of California, Riverside, USA. Prior to joining IIT Jodhpur, Dr. Vankayala served as Chief Technology Officer at Radoptics LLC, USA, where he contributed to the development of translational optical nanomedicines. At IIT Jodhpur, his group has pioneered biomimetic and near-infrared-responsive nanomaterials, including erythrocyte-derived nanoparticles, supramolecular dye assemblies, two-dimensional nanomaterials, and emerging borophene-based systems for applications in cancer theranostics, antimicrobial therapy, biofilm eradication, and precision medicine. Dr. Vankayala has authored over 80 peer-reviewed publications and holds multiple patents. His contributions have been recognized through several honours, including the Ramalingaswami Biomedical Fellowship, the Research Excellence Award at IIT Jodhpur, the ACS Rising Star in Biological, Medicinal, and Pharmaceutical Chemistry (2024), and inclusion among Stanford University's World's Top 2% Scientists. He currently serves on the editorial boards of several international journals, including Scientific Reports (Nature Portfolio), Particle (Wiley) and Frontiers in Drug Delivery.

Programming Light And Matter For Precision Biology

Raviraj Vankayala

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Abstract

The convergence of materials science, photonics, and biology is creating unprecedented opportunities to address some of the most pressing challenges in healthcare. By precisely engineering the interactions between light, functional materials, and biological systems, it is now possible to develop intelligent platforms capable of disease detection, image-guided intervention, and targeted therapy with minimal off-target effects. In this lecture, I will present our recent efforts toward the development of light-responsive bioengineered nanoplatforms for precision biology and medicine. The talk will highlight the rational design of near-infrared (NIR)-activatable nanomaterials, including biomimetic erythrocyte-derived particles, indocyanine green (ICG)-based supramolecular assemblies, plasmonic nanostructures, two-dimensional nanomaterials, and emerging borophene platforms. These systems exploit the unique ability of NIR light to penetrate biological tissues and remotely regulate therapeutic and diagnostic functions with high spatiotemporal precision. I will discuss how the programming of material properties at the nanoscale enables multifunctional biological outcomes, including enhanced molecular imaging, controlled drug delivery, photodynamic and photothermal therapy, modulation of cellular metabolism, and eradication of bacterial biofilms. Further, these technologies will be leveraged to address diverse biomedical challenges ranging from cancer and antimicrobial resistance to wound healing and precision diagnostics. Finally, I will outline emerging opportunities at the interface of light, matter, and biology, where programmable nanobiointerfaces may serve as next-generation tools for precision healthcare and translational medicine.

Keywords: Theranostic Nanoplatforms, Indocyanine Green, Biomimetics, Photothermal Therapy, Photodynamic Therapy



Dr. Ritu Kulshrestha

Director Professor and Head, Dept of Pathology
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Dr Ritu Kulshrestha, is the Director Professor and Head, Department of Pathology, V.P.Chest Institute, University of Delhi since 2012. She established the Molecular pathology laboratory at VPCI in 2009 and since then has been leading her research group in the field of non-communicable lung diseases including Lung fibrosis and lung cancer and the nanotherapy of these diseases. Her group has been regularly performing qRT-PCR, Sanger Sequencing, EGFR, ALK-1, BRAF, KRAS mutation analysis, Cell culture, nanotherapeutics for personalized therapy.

Since 2010 she has been the Principal Investigator/Co-Investigator of 14 extramural funded research projects (funded by ICMR, DST-fast Track, SERB, ICMR-nano Task Force, DHR, VPCI-DHR-ICMR-MRU, CSIR, LSRB-DRDO). Her group has been regularly performing Genomics-qRT-PCR (EGFR, ALK-1, BRAF, KRAS, ROS-1 mutations), Sanger Sequencing, on lung cancer patients, Immunotherapy (PD-L1, CTLA4), Proteomics (IL-6, TNFα, TGFβ) on patients, preclinical studies on lung fibrosis, invitro Cell culture (A-549, U-937, THP-1, etc), invivo animal preclinical studies (bleomycin induced Wistar Rat model of lung injury and Cigarette smoke model, miRNA posttranslational modification in lung fibrosis, Gene/siRNA therapy of lung fibrosis, nanotherapeutics for personalized therapy of Lung fibrosis/lung cancer and alteration of Signaling pathways with antifibrotic therapy (Pirfenidone). She has also worked on attenuation of lung and vascular remodelling by using repurposed drugs-N-acetylcysteine, Sildenafil, Bosentan, Pioglitazone.

The results of her ICMR-Nanotask force project (2019-23) include Novel nanoformulation of Pirfenidone for inhalational therapy in bleomycin induced rat model of lung fibrosis and have being filed by ICMR for Indian Patent-No-202411044031.

She has authored 54 papers in National and International Journals on various aspects of lung fibrosis and lung cancer, 17 Book chapters and edited 5 books. She has co-supervised 8 MD thesis and has been coinvestigating Department in 3 PhD thesis. Dr Ritu Kulshrestha has received two international fellowships- at Mayo clinic Arizona and University of Graz, Austria.

She has been the Member-Secretary of Dept of Health research funded VPCI-DHR-ICMR-Multidisciplinary Research Unit from 2014-2019. She is the Co-Chairperson of the SAC committes of MRHRU-Khotpura and MRHRU- Dhada and Associate Member- of DBT– TDNBC–Deakin–Research Network across Continents for Learning and Innovation (DTD-RNA) since 2020.

She is Member expert committee for the Innovation and startup policy and Incharge of Research Park, Institute of Nano Medical Sciences, University of Delhi. She has research projects and collaborations with AIIMS Delhi, IIT Bombay, IIT Kanpur, INMAS DRDO, DIPAS, Miranda House, DU, Amrita Inst, Kochi, Jamia Milia Islamia (among Others). She is member of the Board of Studies of- SGT University and Delhi Skill and Entrepreneurship (DSEU) University, Delhi.

Designing Nanotheranostics for diagnosis and personalised therapy of Lung fibrosis and lung cancer

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Abstract

The diffuse parenchymal lung diseases (DPLD) such as lung fibrosis and lung cancer are diagnosed by conventional clinical-radiological-pathological correlation. Their early pathological diagnosis, biomarkers of progression and personalized therapy are needed to improve their high mortality and morbidity. The existing conventional therapies are associated with systemic side-effects, early resistance, poor compliance and high cost. The integration of targeted nanocarriers with diagnostic imaging and therapeutic payloads is an unmet need and therefore being evaluated.

Nanotheranostics offers a powerful Strategic option for diagnosis and personalised therapy of both lung fibrosis and lung cancer. Current advances are focusing on designing siRNA-loaded nanoparticles, fibrosis-targeting nanocarriers, and immune-modulating nanoparticles that can dismantle tumor-associated fibrotic barriers.

At nanomedicine laboratory, VPCI we have synthesized, characterised and demonstrated the efficacy of polymeric NPs, siRNA conjugated mesoporous silica (MSN-NPs) and their hybrid- NPs invitro and delivery in vivo in multiple stages of DPLD (from diagnosis to therapy), via inhalational route. This has immense potential for personalised therapy of DPLD including early diagnosis; delineation of extent of disease/staging; determining tumor volume in lung cancer and studying rate of progression/ response to therapy, delivery and targeted therapy to cells of interest/ pathogenesis of lung fibrosis.

The key designing strategies used in our Laboratory, the challenges such as toxicity and biosafety of these nanomaterials and the available nano strategies to overcome these issues will be discussed. Further their clinical translation and the road ahead for nanotheranostics of DPLD will also be elaborated.



Prof. Seema Bhatnagar

Amity Centre for Nanomedicine, Amity University Uttar Pradesh Noida

rof. (Dr.) Seema Bhatnagar is a Professor and Additional Director at the Amity Institute of Biotechnology, Amity University, Noida. She holds a Ph.D. in Chemistry from the Central Drug Research Institute (CDRI), Lucknow, and has over two decades of experience in research and teaching. Her research expertise includes small-molecule drug discovery, medicinal chemistry, organic synthesis, natural products, smart drug delivery, and anticancer therapeutics.Her research focuses on the design and development of novel bioactive molecules and targeted therapeutic approaches, with particular interest in cancer biology and drug delivery. She has worked extensively on synthetic chemistry and the development of potential therapeutic agents and has contributed to multidisciplinary research involving medicinal chemistry, biotechnology, and biomedical sciences.Prof. Bhatnagar has published her research in reputed international journals and has been involved in several collaborative and externally funded research programmes. She has received international research fellowships and grants, including the UICC Yamagiwa-Yoshida Memorial International Cancer Study Grant and an Adjunct Research Scholar Fellowship at Indiana University, USA. She continues to contribute actively to research, teaching, mentoring, and scientific collaborations in the field of drug discovery and translational medicine.

Folate Receptor-Targeted Smart Delivery of Curcumin for Selective Targeting of TNBC and Cancer Stem Cells

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Abstract

Breast cancer remains one of the most commonly diagnosed cancers worldwide. According to GLOBOCAN 2022, it is the leading cancer among Indian women, accounting for nearly 27% of all female cancers. India reported approximately 192,020 new cases and 98,337 deaths in 2022, with a substantial burden of Triple-negative breast cancer (TNBC) among younger women. Projections indicate that breast cancer incidence and mortality expected to rise markedly by 2050.

TNBC is an aggressive subtype with limited targeted treatment options, represents a significant therapeutic challenge, particularly in India. Neoadjuvant chemotherapy (NAC), with or without immunotherapy, remains central to early-stage TNBC management; however, treatment response varies considerably. There is an urgent need for personalized systemic treatment strategies that identify patients likely to benefit from treatment, thereby improving outcomes and minimizing the potentially life-altering toxicities of current therapies. Conventional drug delivery systems (DDSs) are often accompanied by systemic side effects and toxicity that are mainly attributable to their nonspecific bio-distribution, uncontrolled drug release characteristics and low bioavailability. These challenges coupled with activation of compensatory signalling pathways post drug treatment leads to drug resistance. Therefore, there is an urgent need to identify innovative drug delivery strategies that can deliver cancer drugs. Smart Drug Delivery Systems (SDDS) allow lower drug doses to be administered while maintaining effective intracellular concentrations, therefore expanding the therapeutic window of anticancer drugs. SDDSs have several advantages, including improved specific localization, patient compliance, reduced toxic side effects, and controlled biodistribution.

The drug targeting is a crucial aspect of SDDS. Folic acid (FA) is the natural ligand of folate receptor (FR) that is a glycosylphosphatidylinositol-linked membrane protein . The FR typically binds to folic acid as well as 5-methyltetrahydrofolate and transport them by a non-classical endocytic mechanism. There are four isoforms of FR have been described: α, β, γ and δ. FR-α is most widely expressed exclusively on the apical surface of polarized epithelial cells of cancer cells. Accordingly healthy polarized epithelium is inaccessible to parenterally administered drugs. However, the tight junctions between epithelial cells collapse after malignant transformation, allowing the apically restricted receptors to redistribute to all cancer cell surfaces. Apically restricted proteins are good targets for small molecule drug conjugate (SMDC)-mediated drug delivery because 80% of human cancers are derived from epithelial cells.

Curcumin (CUR) is a small molecule that has been shown to possess antioxidative, antiviral, anti-inflammatory, antibacterial and antihyperglycemic activity. Furthermore, the anticancer property of CUR in breast, lung, pancreatic, and colon cancer have been demonstrated. However poor absorption, low bioavailability, rapid metabolism and rapid elimination makes it a challenging molecule as an adjuvant therapy. Numerous studies have demonstrated the chemo and radio sensitizing effects of CUR in combination with various chemotherapeutic agents.

The current study explores CUR-FA SMDC for targeted delivery to cancer cells. The conjugate was synthesized using Steglich esterification and has been characterized using 1D and 2D NMR techniques. The study also explores the specific signalling pathways and the chemo sensitizing nature of the bioconjugate in TNBC cell lines.



Prof. Sirsendu Sekhar Ray

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Dr. Sirsendu Sekhar Ray undergraduates as Bachelor of medicine and Bachelor of Surgery from Dr. Sampurnanand medical college, Jodhpur, Rajasthan. He earned his Master's degree in medical science and technology from IIT Kharagpur, West Bengal, where he studied the effect of audio binaural stimulation on the autonomic nervous system. Meanwhile, he worked as a Post-doctoral trainee with Prof. Zvia Breznitinz, laboratory of neurocognitive research, Haifa University, Israel, on the accelerated reading paradigm for dyslexic children. He also visited National Institute of Physiological Science, Okazaki, Japan to learn brain-machine interface technology. Upon completing his masters, he joined NIT Rourkela as an Assistant Professor. At NIT Rourkela, he completed his PhD under the guidance of Prof. Sunil Kumar Sarangi and Prof. Krishna Pramanik on the cryopreservation of adipose tissue and adipose tissue derived stem cells, where he developed cryoprotectant solutions for stem cell therapy. In the last few years, his research interest mainly revolves around nanotechnology, biomolecular electronics and healthcare engineering. He has number of patents and publications in reputed journals on these topics. His notable contribution is development of biomolecular glass with in-situ formed nanodiamonds from DNA, RNA, ATP and egg yolks. He has also developed green synthesis processes for the mass scale production of nanodiamonds at low pressure and temperature. He also proposed the consciousness driven experimental evolution in living systems and probable presence of wired and wireless communication among the biomolecules. Moreover, he enjoys teaching, discussing ideas, and engaging in entrepreneurial endeavors.

Atomic-scale Mechanistic Insights Into The Hydrothermal Synthesis Of Ultra-nanocrystalline Diamonds

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Abstract

Diamond formation under hydrothermal condition particularly at low-pressure and low-temperature remains mechanistically unclear. This study investigates the atomic-scale insights governing the hydrothermal synthesis of ultrananocrystalline diamonds from CHO precursors. CHO precursors were treated at 190 °C for 4 h in strongly alkaline aqueous media. The products were characterized using ultra-high-resolution transmission electron microscopy, FFT–IFFT analysis, spatial d-spacing analysis and X-ray photoelectron spectroscopy.

Nanocrystalline diamonds of approximately 4–15 nm sizes were observed within amorphous and graphitic carbon matrices. Contraction of graphitic interlayer spacings progressively from 3.2–3.5 Å to diamond-specific spacings of 2.06 and 1.26 Å indicate that graphitic layers transform into diamond {111} and {220} planes. Both coherent interfaces, meaning ordered lattice rearrangement, and incoherent graphite–diamond interfaces containing atomic disorder were identified. Compressed graphitic planes in the forms of localized lattice buckling, notches, multiaxial distortion and stacking faults were observed that reveals physicochemical stresses mediated diamond nucleation. Furthermore, transitions between graphitic, hexagonal-diamond and cubic-diamond stacking arrangements demonstrated rotational, reflection, pentagonal and hierarchically stacked twins. Incomplete transformation and graphite–diamond heterostructure formation showed residual graphene-like layers enclosed within cubic-diamond regions.

Overall, the findings support a two-stage mechanism involving initial atomic rearrangement of CHO precursors and condensation of them into sp^2-rich intermediates, followed by salt-assisted, stress-mediated sp^2-to-sp^3 rehybridization. Furthermore, multiple factors such as ionic catalysis, chemical decomposition, compression, defects and twinning may have collectively reduced nucleation barriers and drive ultrananocrystalline diamond formation under mild hydrothermal conditions

Keywords: Ultra-nanocrystalline diamonds, Hydrothermal Synthesis, Ultra-HRTEM



Prof. Subhash Chandra Yadav

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Prof. Subhash Chandra Yadav is an Additional Professor in the Department of Anatomy at the All India Institute of Medical Sciences (AIIMS), New Delhi, with expertise in 3D electron tomography, electron microscopy, nanotechnology, and nanobiology. He received his Ph.D. in Molecular Biology from Banaras Hindu University in 2007. He subsequently undertook research training at the Free University Berlin, Germany, the Indian Institute of Science, Bengaluru, and the University of Tennessee, USA. He also served as Scientist-in-Charge of the Nanobiology and Electron Microscopy Facility at CSIR-IHBT, Palampur, and worked at the TERI-Deakin Nanobiotechnology Centre, New Delhi, before joining AIIMS in 2015.His research interests include nanotechnology-based diagnostic systems, targeted drug delivery, nanomedicine, and the therapeutic applications of biomolecules. His research has explored nano-based approaches for cancer diagnosis and therapy, including targeted nanocarriers and rapid diagnostic platforms. He has been involved in several externally funded research projects and has contributed extensively to interdisciplinary research at the interface of nanotechnology, molecular biology, and biomedical sciences. Prof. Yadav has also contributed significantly to training and capacity building in electron microscopy and nanobiology and continues to pursue translational research in biomedical nanotechnology.

Achievements/Awards:
National Bioentrepreneurs Competition Award with a cash prize of 5 lakh at C-CAMP, Bengaluru (2025)
C. V. Raman Memorial Award at the International Conference on Biomaterials and Health Care (BioHeal-2025)
Elected Fellow of Electron Microscopy Society of India (2024)
Excellence in Microscopy Award for Medical Sciences by Electron Microscope Society of India (EMSI) (2018)

Nanoengineered Immunofluorescence Assay for Fast and Sensitive Detection of Cervi cal Cancer at early stage

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Abstract

Biopsy-based histopathology and immunohistochemistry for cervical cancer detection are costly, time-consuming, and require expert personnel for data interpretation. We developed a simple magnetic nano-particle (MNP) and quantum dot (QD)-coupled immuno-nanofluorescence assay (MNPQDNCFA) for the visual detection of HPV high risk-induced cervical cancer cells under UV light from cytology/biopsy samples, exploiting host cancer cells expressing viral E7 protein as a biomarker. The E7 domain-specific polyclonal antibodies were generated against the 1–44 amino acid N-terminal (anti-domain N antibody) and 48–98 amino acid C-terminal domain (anti-domain C antibody). These antibodies were bioconjugated with nanofluorescent MNPs (60% efficiency) and fluorescent QDs (66% efficiency) to generate capturing (MNPs–anti-domain N antibody) and detecting (QDs–anti-domain C antibody) nano-complexes, respectively. Assay conditions, such as the concentration of capturing (20 µM) and detecting (50 nM) antibodies, nano-complexes, and incubation duration (30 min), were standardized. The analytical sensitivity using pure HPV E7 protein was recorded up to 200 ng with very high specificity to differentiate it from other HPV strains' E7 proteins. The diagnostic performance characteristics with cytology samples showed 100% sensitivity and specificity compared to immunofluorescence and biopsy-based histopathology analysis. The present invention can be effectively used as a quick, disposable, rapid cervical cancer cell detection system as an alternative test to immunofluorescence and histopathology.





Dr. Subash Chandra Gupta

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Dr. Subash Chandra Gupta is a Professor and Head at Department of Biochemistry, All India Institute of Medical Sciences (AIIMS), Guwahati. Dr. Gupta and his team has developed a diagnostic facility that caters the need of biochemical and molecular investigations for patient care at AIIMS Guwahati. He has contributed significantly in understanding the role of inflammatory pathways in cancer pathogenesis. His current research focuses on elucidating the role of metabolic reprogramming in cancer types, particularly breast and head-and-neck cancer. His laboratory is also working on cancer chemoprevention and other projects to understand the role of cancer stem cells, exosomal microRNAs and long non-coding RNAs in regulating tumor development. He has published over 140 peer-reviewed articles in highly prestigious journals. He has written several book chapters. His work has been cited by a number of prestigious, peer-reviewed, international journals (total citations: > 35,800; 'h' index: 70; i10-index: 127). He has been honoured with prestigious national and international awards. He has co-edited special issues of scientific journals and four prestigious books. Currently he is an editorial board member on several scientific journals and an active reviewer on more than 80 journals. He has been actively involved in teaching undergraduate and postgraduate students. In addition, he has been supervising postgraduate and doctoral candidates.

Harnessing Exosome-Based Delivery to Enhance the Anticancer Activity of an Alkaloid in Triple-Negative Breast Cancer

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Abstract

Piperlongumine (PL) is a bioactive alkaloid derived from Piper longum. This alkaloid has demonstrated anticancer activity in some malignancies. However, its therapeutic application is hindered by poor aqueous solubility, low bioavailability, and inadequate tumor-specific delivery. Triple-negative breast cancer (TNBC) is an aggressive and heterogeneous subtype of breast cancer with limited therapeutic options. In the present study, bovine milk-derived exosomes were employed as nanocarriers for the delivery of PL to TNBC cell lines (MDA-MB-231 and MDA-MB-468). Exosomes and PL-loaded exosomes (Exo-PL) were characterized using physicochemical approaches. Dynamic Light Scattering analysis revealed an average particle size of 71.1 nm with a low polydispersity index (0.120), indicating uniform size distribution. High-resolution transmission electron microscopy confirmed the spherical morphology and low heterogeneity of exosomes, with an average diameter of approximately 60 nm. X-ray diffraction analysis demonstrated the amorphous nature of the exosomal formulation. PL was efficiently encapsulated within exosomes using sonication followed by ultracentrifugation. The therapeutic efficacy of Exo-PL was evaluated using MTT assay, AO/PI staining, DAPI staining, clonogenic assay, mitochondrial membrane potential assay, reactive oxygen species assay, and western blotting. Exo-PL exhibited significantly lower IC50 values compared to PL alone in TNBC cells. Furthermore, Exo-PL induced enhanced cellular and nuclear damage, increased intracellular ROS generation, and marked disruption of mitochondrial membrane potential. Western blot analysis also demonstrated significant modulation of tumorigenic proteins following Exo-PL treatment. Collectively, these findings suggest that exosome-mediated delivery significantly enhances the anticancer efficacy of PL against TNBC. Further in vivo studies are underway to evaluate its therapeutic potential.

Keywords: Alkaloid; Cancer drug; Drug delivery; Exosome; Piperlongumine; Triple negative breast cancer.



Dr. Suman S. Thakur

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Dr Suman Thakur's research interests involve applying Mass Spectrometry and nanomedicine to Health and Diseases, especially identifying Early Biomarkers, understanding Cancer Progression and Metastasis, and advancing Drug Development. His lab uses mass spectrometry-based high-throughput quantitative proteomics, natural product chemistry, cell biology, animal models, nanoparticles, and modern biological approaches to identify targets, develop new drugs, and elucidate their molecular and mechanistic details in cancer.

Investigation of the efficacy of various purified/characterised natural and synthetic metabolites with minimal side effects against different cancers, including childhood and aggressive cancers, using in vitro and in vivo methods, is among his major areas of research.

Further, his interest is in elucidating the mode of action of a few selected compounds targeting cell adhesion, ROS, AKT signalling, and tyrosine kinases in cancer.

Novel nanomedicine strategies for advanced stages and metastatic cancer therapy

Dr. Suman S. Thakur

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Abstract

Cancer is one of the complex diseases and a leading cause of death worldwide, responsible for approximately 10 million deaths in 2024. There are more than 100 types of cancer, each with distinct molecular and clinical characteristics. Despite significant advances in cancer research, the underlying mechanisms driving cancer progression and metastasis are not yet fully understood. Both genetic and environmental factors play important roles in cancer development. Early and accurate diagnosis is critical for effective treatment, as different cancer types and different molecular subtypes require distinct therapeutic strategies, including overcoming drug resistance. Therefore, cancer therapeutics require continuous advancement and the development of novel approaches, including nanomedicine-based strategies. Nanomedicine plays an important role in targeted anticancer drug delivery, controlled payload release, immune modulation, reduced side effects, improved drug solubility, and combination therapies. We have developed several nanopeptide and small-molecule nanoparticle formulations and evaluated their potential as anticancer therapeutics.

Nano-medicine and Mass spectrometry-based proteomics have found applications in biological sciences and medical biology, including both basic and translational research. Targeted and quantitative proteomics can identify the cause of the disease, including narrowing it down to a particular protein/gene. Our group is trying to understand the cancer progression and working to develop novel anticancer drugs against various aggressive cancers, including Melanoma, Breast, Lymphoma, Leukaemia, Colon, Oral and Lung Cancer. We have quantified several thousand proteins across various aggressive cancers to elucidate the mechanism of cancer progression and therapeutics. Melanoma is one of the most aggressive and fatal skin cancers. The morbidity and mortality of this form of skin cancer are escalating every decade. In spite of years of intense investigation, there has been very little development in the survival of patients with disseminated melanoma. Further, Lung cancer is a global problem and occurs in both males and females.

We have successfully investigated the efficacy of various novel natural and synthetic metabolites and nanoparticles targeting oncogenes and cancer suppressor genes in aggressive cancers, including melanoma and lung cancer, using cell culture and mouse models, with the help of quantitative proteomics, molecular biology, and biochemical techniques. The mode of action and targeted signalling mechanism of these novel drugs have been revealed through quantitative proteomics and biochemical techniques. Mass spectrometry results show that Ras-related protein RAP1A, pancreatitis-associated protein 1 (PAP1), and anticarcinoma embryonic antigen light chain variable region (A2NMA3) play important roles in melanoma progression, as demonstrated in in vivo mouse model studies. The in vitro studies suggest up-regulation of p53, Bax, Foxo1, cytochrome c, Caspase-8, 9, 2, 3, and cleaved PARP, along with down-regulation of Bcl2 levels and p-Akt after treatment of melanoma cells. Further, observed apoptosis was mediated in part by a mitochondria-mediated death cascade and by inhibition of Akt signalling in human malignant melanoma cells. Further, an in vivo proteomics study in Lung cancer shows the involvement of several RAS-related proteins, EGFR, TALIN, and ICAM1 in cancer progression and therapeutics.



Prof. Suresh C. Sharma

Department of Applied Physics,
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Dr. Suresh C. Sharma has been working as Professor with the Department of Applied Physics, Delhi Technological University (DTU), Delhi, India since June 13, 2012 and also held administrative responsibility of Dean (Acad.-PG) from September 2, 2019 to August 31, 2022 & HoD (Applied Physics) from August 1, 2012 to September 30, 2018. He was the Chairman, Department Research Committee (DRCs) (Applied Physics), DTU from November 29, 2017 to August 15, 2023. Prior to joining DTU, he has worked as Professor, Department of Physics, MAIT (GGS Indraprastha University, Delhi), Delhi from November 1, 2009 to June 12, 2012. More recently, one of his proposal on Micro & Nano Semiconducting Materials and Devices has been approved for the Establishment of Centre of Excellence (CoE) in Delhi Technological University (DTU), Delhi for an amount of Rs. 8 Crores (70% from DKDF of Delhi Govt., Delhi & 30% from DTU) under DKDF of Department of Training and Technical Education (DTTE), Govt. of Delhi (CoE Incharge: Prof. Suresh C. Sharma). In addition, one Patent Titled "Biosensor for Detecting Biomolecules" Suresh C. Sharma and Mansha Kansal, Filed on May 16, 2025 at the Indian Patent Office (Application no. 202511047413, Patent No.:585267; Patentee: Delhi Technological University) has been granted on 27/03/2026.

He was awarded the Young Scientist project as a Principal Investigator by the Department of Science and Technology (DST), Govt. of India for 2 years (1997-99). He was a Monbusho Postdoctoral Fellow under Japanese Govt. fellowship, Department of Physics, Faculty of Science, Ehime University, Matsuyama, Japan from October 1997 to March 1999. In addition, he has been a JSPS (Invitation) Postdoctoral Fellow and visiting researcher from May 2004 to October 2005 with Centre for Atomic and Molecular Technologies (CAMT), Osaka University, Japan. Also, he was awarded Senior Research Associate under the Scientist's Pool Scheme by CSIR, Govt. of India for 3 years (1999-2002). He has established Plasma and Nano Simulation Research Lab; EMT, Antenna & Propagation Lab; Microwave Engg. Lab; Advanced Semiconductor and Microwave Devices Lab. at DTU, Delhi. He has guided 22 Ph.D. Students and several M. Tech & B. Tech students. I have published 236 research papers in Journals of International & National repute and Proceedings of International & National Conferences. I have extensive work experience in experimental and computational plasma research. He has worked on several research projects in India and abroad. He has delivered several invited and oral talks in India and abroad. He has also organized a number of conferences and seminars at DTU, Delhi. He was awarded commendable Research Award for Excellence in Research by DTU, Delhi for 8 consecutive years i.e., March 2018, March 2019, March 2020, Feb 2021, March 2022, April 2023, September 2024 and September 15, 2025. He is a Member of the American Physical Society (APS), USA; Senior Member of the Institute of Electrical and Electronics Engineers (IEEE), USA; Member of the International Association of Engineers (IAENG), Hong Kong; Member & designated delegate of Asian African Association for plasma Training (AAAPT); Member of the Association of Asia Pacific Physical Societies- Division of Plasma Physics (AAPPS-DPP); Member of the National Academy of Sciences (MNASc), India; Life Member - Plasma Science Society of India (PSSI); Life Member- Indian Science Congress Association (ISCA) and Life Member -Indian Society for Technical Education (ISTE), New Delhi, India.

Plasma-Assisted Semiconducting Carbon Nanostructures Field-Effect Transistors for Nano-biosensing Applications

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Abstract

Plasma-Assisted Semiconducting Carbon Nanostructures (CNT & Graphene) field-effect transistors (PA-SCN-FETs) have shown great potential for highly sensitive nano-biosensing applications due to their outstanding electrical characteristics. This research focuses on the modelling and simulation of a plasma-assisted PA-SCN-FETs fabricated through the plasma-enhanced chemical vapor deposition (PECVD) process. A detailed analysis is conducted to evaluate how different plasma parameters influence the device's electrical behaviour and overall performance. The simulation results indicate that optimizing plasma power and pressure enhances the transistor's functionality by increasing drain current, improving output conductance, and lowering the cutoff frequency. These results emphasize the importance of precise plasma control in maximizing device efficiency. The proposed PA-SCN-FETs design aligns strongly with experimental observations, confirming its feasibility for real-world nano-biosensing applications. This study provides critical insights into the role of plasma-assisted fabrication in advancing PA-SCN-FETs technology for next-generation Nano-biosensors.

Keywords: Semiconductor, Carbon Nanostructures, PECVD, Cancerous Biomolecules

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Dr. Suveen Kumar is working as Assistant Professor at Department of Medical Devices, National Institute of Pharmaceutical Education and Research -Ahmedabad, Gujarat, India. Before joining of NIPER-Ahmedabad, He was served at University of Delhi as DST-INSPIRE Faculty and SERB-Research Scientist for more than five years. He also worked as a Postdoctoral Research Associate at the Ulsan National Institute of Science and Technology (UNIST), Ulsan, Republic of Korea. Dr. Kumar received his Ph.D. in Biotechnology from Delhi Technological University (DTU), Delhi, India, in 2017. His research focuses on synthesizing nanomaterials and developing electrochemical biosensors for various diseases diagnosis, including oral cancer, liver cancer, lung cancer, cardiovascular diseases, swine flu, and stress-related conditions.

His research also focuses on developing non-invasive disease detection methods using specific biomarkers in biological fluids such as saliva, sweat, and urine. He has published more than 60 articles in well reputed peered reviewed international journals. His publications have received more than 3,000 citations, with h-index of 26, and an i10-index of 42. He has received several awards, project grants and recognitions for his research contributions. He was recognized among the Top 2% of Scientists in 2024 and 2025 by Stanford University and Elsevier, and among the Top 5% of Scientists in 2025 by SciRank Global. He also received the Padma Bhushan Prof. Gurbaksh Singh Memorial Oration Award from the Institute of Nano Medical Sciences (INMS), University of Delhi, and Maharaja Surajmal Brij University (MSBU), Bharatpur, in 2024. In addition, he received the SERB Research Scientist (SRS) Scheme Award in 2022, the Commendable Research Award from Delhi Technological University in 2020, and the INSPIRE Faculty Award in 2017. He was awarded various projects during this tenure from various funding agencies like DST, SERB, DBT, ICMR, ANRF etc. Till date, he has guided 04 Ph.D. Students and more than 30 MS/M.Tech. students. He is currently supervising 04 Ph.D. Students and 09 M.Tech. Students.

Nanomaterial Synthesis to Electrochemical Diagnostics Devices Development

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Abstract

The translation of nanomaterial synthesis into electrochemical diagnostic devices represents a multidisciplinary pathway connecting materials engineering with biomedical sensing. Rational design of nanomaterials, controlled surface functionalization, and electrode integration can enhance electrochemical signal transduction, analytical sensitivity, selectivity, and device miniaturization, facilitating the development of advanced platforms for rapid and decentralized diagnostics. Graphdiyne has emerged as a promising nanomaterial and a competent candidate against graphene. Hydrogen-substituted graphdiyne (HsGDY), the least atomically dense graphdiyne with the largest pore-forming structure, is formed by H-substitution at meta positions and comprises repeated 1,3,5-triethynylbenzene units interconnected through meta positions. Unlike carbon allotropes containing predominantly sp^2-hybridized carbon, HsGDY possesses abundant sp and sp^2 carbon atoms, imparting a natural semiconducting band gap, porous structure, negative zeta potential, high carrier mobility, and large surface area. These properties make HsGDY a potential nanostructured material for biosensing applications.

In our first work, HsGDY nanosheets were explored as an immobilization matrix for detecting the liver cancer biomarker Annexin A2 (ANXA2). ANXA2 is elevated in the serum of liver cancer patients, with a reported cutoff value of 18 ng mL^{-1} and diagnostic accuracy of ~92%. The developed biosensing platform exhibited a wide linear detection range (LDR) of 0.01 fg mL^{-1}–1000 ng mL^{-1} and enabled detection of three ANXA2 molecules with high sensitivity. However, the immunoelectrode remained stable for only 35 days, possibly due to weak physical adsorption of bioreceptors. Therefore, HsGDY was extrinsically modified with 3-aminopropyltriethoxysilane (APTES) to enable covalent immobilization of anti-ANXA2, extending durability to 63 days but reducing sensitivity, likely due to the non-conducting APTES layer hindering electron transfer. Subsequently, intrinsic modification of HsGDY produced HsGDY oxide, which demonstrated improved biosensing performance, with an LDR of 10^{-} – 10 ng mL^{-1}, sensitivity of 8.6 µA $[\log(\text{ng mL}^{-1})]^{-1}$ cm^{-2}, and shelf life of 84 days. Furthermore, validation using serum samples showed high correlation with ELISA results.



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Tiju Thomas, a Professor at the Department of Metallurgical and Materials Engineering (Indian Institute of Technology Madras, IITM) in Chennai, India.

Before coming to IITM, I was working as a Faculty Fellow at the Materials Research Center in the Indian Institute of Science, Bangalore. Prior to that I was on an industry-academia joint project involving University of Toronto, Memorial University of Newfoundland, and Lumentra Inc. (a start up company, specializing in light emitting devices). Before that I was pursuing my graduate degrees (MS, PhD) at the School of Engineering in Cornell University. I was enrolled in an interdisciplinary program, which enabled me to work with electrical engineers, applied physicists and solid state chemists. These years, I think, informed much of my current research philosophy. Before leaving for Cornell, I was pursuing my masters (M.S (Engg.)) at the Theoretical Sciences Unit in Jawaharlal Nehru Centre for Advanced Scientific Research. Here is where I learnt the essentials of solid state sciences, which has stayed with me ever since. I am grateful to all my teachers and colleagues, from whom I continue to learn.

Disease as a Materials Phenomenon: Reading The Chemistry, Structure and Mechanics of Life

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Abstract

Living tissues are dynamic, adaptive, non-equilibrium materials that continuously remodel, repair and respond to environmental cues. Disease, in this view, is not merely biological damage: it is an altered trajectory in the material evolution of living matter. As pathology progresses, it leaves measurable signatures in chemistry, nanostructure, microstructure, interfaces and mechanical properties, often at the molecular and nanoscale, long before clinical symptoms emerge. The central argument of this lecture is that nanomedicine, reframed as an observational and interpretive instrument rather than primarily a delivery platform, is uniquely positioned to read these earliest material departures from health. This argument is grounded in three collaborations that emerged unexpectedly from the author's primary research in electrochemistry, catalysis and nanomaterials. The first produced and validated a structured instrument for measuring patient-perceived quality of tuberculosis care in India, demonstrating that previously invisible dimensions of care become tractable once the right measurement framework is applied (Cronbach alpha > 0.80 across all domains). The lesson generalises: medicine progresses whenever a previously unmeasured variable is brought within the reach of rigorous quantification. The second demonstrated that a large language model, deployed with a structured prompt-generation checklist, functions as a new integrative scientific sense. The third examined radicular dentin from diabetic and non-diabetic patients subjected to multispecies biofilm challenge. Nanoindentation and vibrational spectroscopy revealed approximately 20% reduction in dentin hardness and significant alteration of the mineral-to-collagen ratio in diabetic samples: changes invisible to clinical inspection alone and interpretable only through the vocabulary of materials science. This work was selected as the Paper of the Year 2025 by the Editorial Board of the Journal of Endodontics, American Association of Endodontists. Together these collaborations support a convergent thesis. The materials science framework - structure governs property governs performance - maps with productive precision onto pathological tissue evolution. Nanoparticle-based sensors reporting on local pH, mechanical stress, enzyme activity and oxygen tension transform nanomedicine into a real-time characterisation platform for living matter. Artificial intelligence integrates multi-scale signals from molecular, tissue, clinical and population levels into actionable diagnostic and therapeutic inference. The convergence of materials characterisation, nanoscale observation and machine learning constitutes a genuinely new language for disease, translatable into scalable, frugal solutions of relevance to clinical practice, industry and public health. This convergence argument has a direct implication for India and the global south. The solutions that the region's disease burden demands are inherently multi-disciplinary: biology, materials science, engineering, data science, clinical science, social science and public policy are all necessary simultaneously, not sequentially. The capabilities and capacities required already exist across institutions - strong materials science and nanomedicine infrastructure, large and clinically diverse patient populations, demonstrated frugal innovation culture, and sustained investment through DST, DBT, ANRF and ICMR. What is underdeveloped is the systematic integration of these elements. Fragmented knowledge ecosystems are a principal impediment to timely progress despite demonstrated capability. Crucially, individual researchers cannot reasonably be expected to generate the required cross-disciplinary linkages by themselves: institutional and programmatic mechanisms for integration, designed to bring diverse disciplines together around shared disease problems, are needed. This lecture is offered as a conversation starter toward building those mechanisms.

Keywords: Nanomedicine, materials science, disease, non-equilibrium, biofilm, tuberculosis, convergent science



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Area of Specialization/Interest: Development of vaccines and immunotherapeutic approaches for bacterial and fungal infections based on synthetic oligosaccharides.

Generation of carbohydrate-specific antibodies and development of tools for medical diagnostics. Fundamental research in the field of glycoimmunology.

Antibodies to Fungal Polysaccharide Antigens: New Horizons in Laboratory Diagnosis of Mycoses

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Abstract

In recent decades, fungal infections have become a global threat, with mortality rates exceeding to those of tuberculosis and malaria. According to data from more than 120 countries, approximately 6.5 million cases of invasive fungal infections are reported annually, nearly 3.8 million of which result in death.1 Despite the clear need for early diagnosis of fungal infections, the arsenal of available laboratory methods for detecting mycoses remains limited. This underscores the urgency of developing new highly sensitive sensor systems capable of recognizing specific fungal markers at ultra-low concentrations. The insufficient effectiveness of modern enzyme-linked immunosorbent assay (ELISA) systems is due to the fact that the antibodies used in their composition are produced using natural polysaccharides, which exhibit high structural heterogeneity, variability in composition, and a wide range of molecular weights. Moreover, the structure of the epitopes recognized by such antibodies often remains undefined.[2,3] A potential solution to this problem is the use of synthetic carbohydrate oligosaccharides with precisely defined structures for antibody generation, mimicking specific fragments of mycopolysaccharide chains.[4,5] This study reports the rational design of monoclonal antibodies specifically targeting pre-determined chemical structure within key fungal cell wall polysaccharides, including β-(1 3)-glucan, β-(1 6)-glucan, mannan, and galactomannan. Our strategy was based on the selection of appropriate marker structure by analysis of current knowledge of fungal polysaccharide architecture. At the next stage, oligosaccharide synthesis of the target carbohydrate sequences and their corresponding conjugates was performed, including immunogens, ELISA coating antigens, and synthetic mimetics of natural polysaccharides. Then monoclonal antibodies with pre-determined specificity were generated using hybridoma technology, and their affinity and specificity were comprehensively characterized using a combination of physicochemical and immunochemical methods. The resulting antibodies demonstrated efficient. recognition of clinically significant fungal species, including Candida albicans, Aspergillus fumigatus, Cryptococcus neoformans, and Malassezia furfur. These antibodies provide a robust foundation for the development of diagnostic systems based on diverse technological platforms, including nanophotonics, nanobiosensors, and electrochemical devices. Overall, the integration of structural, synthetic, immunological, and biotechnological approaches enabled the generation of highly specific antibodies with superior selectivity for fungal biomarker detection.

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Area of Specialization/Interest: My research interests focus on the development of stereoselective synthetic approaches to carbohydrate structures that have potential as biomarkers of infectious diseases, particularly fungal infections. The current project is aimed at identifying a universal marker antigen of Cryptococcus neoformans for the development of diagnostic and immunotherapeutic tools for cryptococcal infection.

Synthesis And Immunochemical Properties Of Oligosaccharide Conjugates Related To Cryptococcus Neoformans Gxmgal

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Abstract

Cryptococcus neoformans is a fungal pathogen that affects multiple organs, including the central nervous system, and causes life-threatening cryptococcal meningitis (CM).Since 2022, C. neoformans has been ranked among the highest-priority fungal pathogens by the World Health Organization. This designation reflects the high mortality rate of CM even under treatment, the limited arsenal of antifungal drugs, and the increasing emergence of drug resistance. In recent years, the at-risk population—previously composed mainly of immunocompromised individuals—has expanded to include immunocompetent patients. However, the most critical challenges in combating cryptococcal infection remain: the lack of affordable, highly sensitive, specific, and minimally invasive diagnostic methods; and the absence of effective anticryptococcal vaccines. A key step toward addressing both challenges is the identification of a universal and specific antigen. In Cryptococcus, such antigenic determinants are localized within its prominent polysaccharide capsule, which is primarily composed of the serotype-defining glucuronoxylomannan (GXM). However, the structure of GXM is highly heterogeneous across serotypes, complicating the identification of a universal antigen. The present work focuses on a minor capsular polysaccharide, glucuronoxylomannogalactan (GXMGal), which exhibits a more conserved structure. In general, GXMGal consists of a poly-α-(1 6)-D-galactopyranan backbone substituted with β-Xylp-(1 3)-α-Manp-(1 3)[β-Xylp-(1 2)-]-α-Manp-(1 4)[β-GlcpA-(1 3)]-β-Galp and β-D-galactofuranosyl residues (Figure 1)

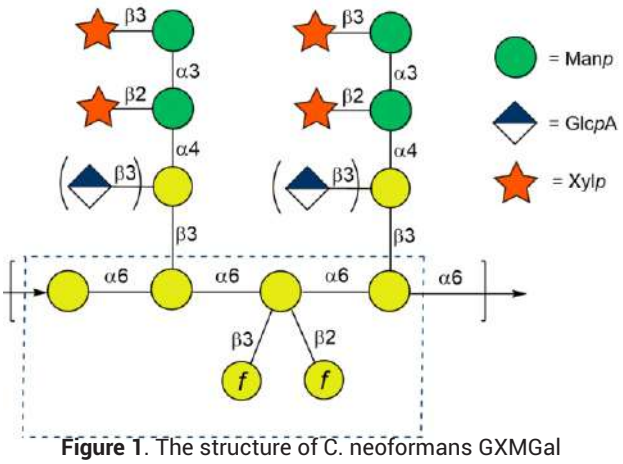


Figure 1. The structure of C. neoformans GXMGal

The key elements of the synthetic strategy included: (1) stereoselective construction of α-(1 6)-galactosidic linkages between Galp units; and (2) enabling selective deprotection of the O-2, O-3, and O-6 hydroxyl groups of the central Galp residue to allow subsequent installation of β-D-galactofuranosyl residues or elongation of the galactopyranoside chain. Complete α-stereoselectivity in the glycosylation reactions was attained due to their cooperative stereodirecting effects. The deprotected oligosaccharides, functionalized with a 3-aminopropyl spacer, were conjugated to bovine serum albumin (BSA) to afford glycoconjugates 3a–5a, which were subsequently used for rabbit immunization. In parallel, the synthesized oligosaccharides were conjugated with biotin (1b–5b) and employed as coating antigens in immunofluorescence assays. Enzyme-linked immunosorbent assay (ELISA) results enabled the identification of a key structural fragment with antigenic potential, providing a foundation for further development of anticryptococcal vaccines and diagnostic systems.

Keywords: Cryptococcus neoformans, glucuronoxylomannogalactan, glycoconjugates, stereoselectivity, glycosylation.



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Scientific H Index 33 achieved with 4500 plus citations. He obtained Ph.D from University of Strasbourg, France, Post Doctoral from University of Regensburg and Karlsruhe Institute of Technology (KIT), Germany. After post -PhD cumulating 20 years international faculty experiences from Medical Universities Amrita, Chonnam Medical School (South Korea), Gulf (UAE) he engaged in identifying good biomarkers for cancer and this led him to determine the role of secretory protein in prostate cancer, how they might contribute to metastasis.

He also studied loss and gain of function using inducible strategy in the cell lines. The goal is to develop a mouse metastatic xeno-graft model in which he could see a tumor affecting the organ in which cancer could be studied.

His research interests include the biological studies of Cancers especially Prostate, Nano Drug delivery and development of xenograft and Knock out animal models for understanding cancer progression.

He is a recipient of Association pour de la researche de cancer French fellowship and Core Research Grant (CRG). He also gained research experience from the International Centre for Genetic Engineering and Biotechnology (ICGEB) India.

Assessment of Tandem Therapeutic Potential of Enzalutamide and Decursin In Vivo Using Elastin Carrier

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Abstract

Castration-resistant prostate cancer (CRPC) frequently develops resistance to androgen receptor-targeted therapies, limiting long-term treatment efficacy. This study investigated the therapeutic potential of elastin nanogel-mediated co-delivery of enzalutamide (EZA) and decursin (DEC) in a DU145 xenograft model of CRPC. Male BALB/c nude mice bearing DU145 tumours were treated with blank elastin nanogel, EZA-loaded nanogel, DEC-loaded nanogel, or combination-loaded nanogel over 28 days. Tumour growth, survival, histopathology, haematological parameters, and serum biochemistry were evaluated to assess therapeutic response and systemic safety. While EZA treatment produced only transient tumour regression and DEC treatment primarily stabilized tumour progression, the combination formulation demonstrated the most consistent and sustained reduction in tumour volume. Histopathological findings supported reduced tumour burden in treated groups without evidence of significant organ toxicity. Haematological and biochemical analyses further indicated acceptable tolerability of the formulations. Collectively, these findings suggest that elastin nanogel-mediated co-delivery of EZA and DEC may represent a promising multi-target therapeutic strategy for overcoming resistance in advanced CRPC.



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Prof. Utkarsh Jain is a Professor at the School of Health Sciences and Technology (SoHST), UPES, Dehradun, India. He completed his PhD in Microbiology/Human Biology from Ludwig Maximilian University of Munich (LMU), Germany, with Magna Cum Laude distinction. His research interests include biomedical and electrochemical biosensors, nanomaterials, molecularly imprinted polymers, infectious disease diagnostics, and translational healthcare technologies. His work focuses on developing sensitive, affordable, rapid, and portable diagnostic platforms for clinically important targets, including H. pylori, glycated hemoglobin, neonatal sepsis biomarkers, and other disease-associated molecules.

Prof. Jain has published more than 170 high impact research publications, 3 authored books and 21 book chapters, and contributed to over 100 international conferences. He has a research h-index of 40, honored with 11 international research awards, holds 27 patents, and has received 9 research funding support worth more than 5.5 crore from major national and international funding agencies, including BIRAC, SERB, DST, UKIERI and DBT. He has also contributed to innovation and technology translation through the development and mentoring of 9 biotechnology startups.

His recognition includes being listed among the world's top 2% scientists in the Stanford-based global ranking and receiving awards for excellence in research, microbiology, nanotechnology, and biosensor development. His interdisciplinary research integrates microbiology, biotechnology, nanoscience, materials chemistry, and biomedical engineering to advance next-generation diagnostic technologies and strengthen research-driven healthcare innovation.

Innovative Nanomaterial based Strategies for Next-Generation Biosensing, Diagnostics and Therapy

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Abstract

Electrochemical biosensing devices combine biological recognition components with electrochemical transducers to identify and diagnose the presence of specific biological analytes. Over the past few years, smart nanomaterials are widely used to amplify the signals in varieties of Bio-diagnostic and sensing devices. The specific biological analytes which have been used are neurotransmitters (Anandamide, Serotonin, and Acetylcholine), bacterial proteins causing neonatal sepsis and gastric cancer, psychoactive drugs, glycated albumin, and glycated haemoglobin. These analytes exhibited remarkable selectivity, specificity, strong binding, low limit of detection, and rapid response to develop Bio-diagnostic Devices. In order to enhance the conductivity of electrochemical sensors designed for various analytes, metallic nanoparticles were utilized on Screen Printed Electrodes on biorecognition Elements including molecularly imprinted polymers (MIPs), Aptamers and Functional Enzymes. A high level of demonstrated linear range of 100 pM–1 nM, with upto 0.01 nM detection limit, and high Selectivity of Analytes were detected. Furthermore, advanced nanomaterials were integrated for sensitive TGF detection, which is crucial in various physiological processes and assessing molecule for controlling immunotherapeutic drug efficacy, offering a valuable tool for disease diagnosis and progression monitoring through Smart nano bio-diagnostic devices. "Furthermore, the integration of nanomaterials with exosome-mediated delivery systems offers a promising strategy for enhancing the targeted delivery of antibiotics to combat antimicrobial resistance (AMR), facilitating the efficient transport of bioactive compounds to cancer cells, and enabling the development of advanced therapeutic delivery vehicles, including hydrogen-based therapies.



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Area of Specialization/Interest: Investigation of the effects of non-ionizing electromagnetic radiation in the millimeter and centimeter wave ranges on tumor progression, with the aim of application in oncology for early diagnosis and safe therapy free from toxic side effects. For the first time, the hypothesis is discussed about the transformation of healthy cells into cancerous ones as a result of a change in the molecular structure of intracellular water from the normal hexagonal to the abnormal cubic phase (which can be caused by radiation, chemical, viral, mechanical and microbiological factors) and the possibility of returning to the original state under the influence of microwave radiation.

Restoration of The Damaged Molecular Structure Of Cellular Water During Carcinogenesis Using Non-ionizing Electromagnetic Microwaves

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Abstract

Background: This is an interdisciplinary study combining medicine and physics. As is well known, such research has recently become particularly effective, often leading to unexpected and highly interesting results and discoveries. Previously, we suggested the possibility of the occurrence of carcinogenesis due to transformation of the molecular structure of intracellular water in healthy tissues from a conventional hexagonal modification to a cubic one under the influence of various external and internal damaging factors (radiation, chemical, viral, mechanical, microbiological). Based on preliminary experimental studies, a new biomedical technology in oncology, devoid of toxic side effects, is being proposed for the first time.

Methods: Microwave exposure was carried out for 0.5 hour by extremely low intensity electromagnetic microwave streams of 1 μW/cm2 at a "therapeutic" frequency of 1.0 GHz or at a "pathological" frequency of 0.99 GHz. The irradiated object was located in the far zone of the cone-shaped antenna. To register the spectrum of resonant frequencies of water-containing objects, a microwave super sensitive radiometer was used.

Results: Found the specific resonance anomalous spectra of water and tissues of malignant tumors and shows their relationship with the cubic modification of the water structure (Fig 1a, 1b). The resonant

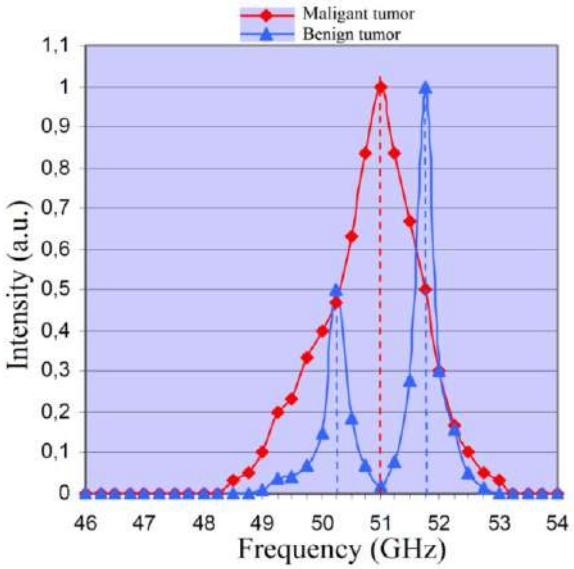


Fig.1a: Resonance spectra of breast pathology: benign (blue) and malignant (red) tumors

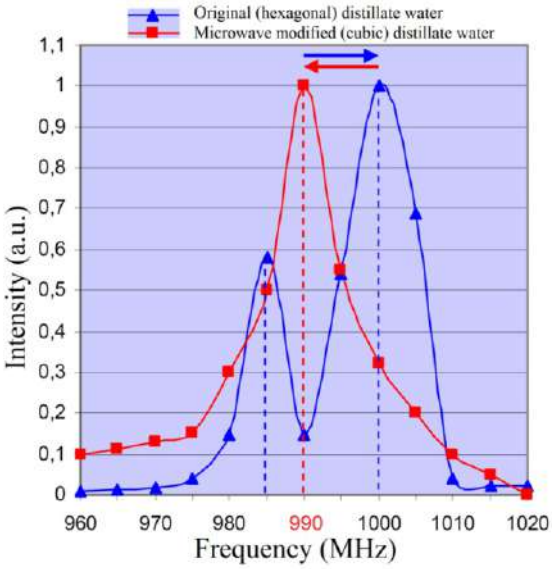


Fig.1b: Mutual phase transformations of the molecular structure of water irradiated with microwaves of "pathological" and "therapeutic" resonant frequencies

Beyond the Skin Barrier: Microneedles for Next-Generation Transdermal Biosensing

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Abstract

The skin is more than a protective barrier—it is a rich, yet largely untapped, source of molecular information. Microneedle-based biosensing is emerging as a powerful strategy to access this information with minimal invasiveness while overcoming the limitations of conventional blood-based diagnostics. This talk will present our recent advances in the development of microneedle-enabled transdermal biosensing platforms for minimally invasive and continuous monitoring of clinically relevant biomarkers and therapeutic targets. By integrating microfabricated microneedle architectures with electrochemical sensing technologies, these platforms enable efficient access to interstitial fluid and sensitive detection of biomolecular signatures directly at the skin interface. Particular emphasis will be placed on the design and fabrication of mechanically robust microneedle arrays, transdermal sampling strategies, sensor integration, and approaches for improving analytical performance and user compatibility. The talk will further highlight the integration of wearable electronics and data-driven approaches toward real-time, personalized health monitoring. Finally, emerging opportunities in multiplexed sensing, smart closed-loop healthcare system will be discussed, highlighting how microneedle technology can transform the skin into an accessible interface for next-generation personalized diagnostics.

Keywords: Microneedle technology; Transdermal sensing; Interstitial fluid; Wearable biosensing.

Oral Presentation

Engineering Quantum Nanomedicine for Decoding and Programming Cellular Electrical Landscapes

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Abstract

Electrical signals govern virtually every aspect of cellular function, from proliferation and migration to intracellular trafficking and disease progression. Yet the ability to interrogate and manipulate these signals within living cells, particularly at the molecular and organelle levels, remains one of the greatest challenges in nanomedicine. This plenary lecture presents our vision for engineering quantum nanomedicine technologies that decode and program cellular electrical landscapes, providing a new framework for understanding and controlling cellular behaviour.

I will introduce our work demonstrating wireless electrical molecular quantum signalling as a new mechanism for regulating cellular function, revealing how engineered nanomedicines can exploit electrical interactions at the molecular scale to direct biological responses. Building on this concept, I will discuss emerging approaches for probing intracellular electrical landscapes with high spatial precision, enabling new insights into how local electrical microenvironments influence intracellular organisation, trafficking, and disease progression. I will then show how externally applied alternating electric fields can regulate intracellular transport, enhance endosomal escape of therapeutic nanoparticles, and improve the efficacy of nanomedicine. Finally, I will discuss the integration of electro-responsive nanomaterials with flexible printed bioelectronics to create programmable, non-invasive platforms capable of both sensing and modulating cellular function.

Together, these advances establish a new technological paradigm at the convergence of quantum nanomedicine, advanced functional materials, and bioelectronics, where molecular electrical interactions can be decoded and harnessed to develop programmable therapeutic strategies. The lecture will highlight the potential of these technologies to shape the future of bioelectronic medicine and electro-pharmaceutics, with broad implications for precision oncology and other complex diseases.

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SnS2 nanoflakes-modified electrode for sensitive and selective electrochemical detection of caffeine, theophylline and guaiacol in green tea, green coffee, coffee and tea extracts

Dr. Amisha

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Abstract

Design of frizzled class receptor 2 targeted novel car-t cell constructs for breast cancer immunotherapy

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Abstract

Cancer is a group of diseases with high mortality, while tumour heterogeneity, therapeutic resistance, toxicity, and relapse limit the effectiveness of conventional treatments. CAR-T-cell therapy is a promising precision immunotherapy in which genetically engineered T cells recognize tumour-associated surface antigens through an antibody-derived single-chain variable fragment (scFv). Fifth-generation CAR-T cells incorporate JAK–STAT signalling modules to further enhance T-cell activation and cytokine-mediated responses. Triple-negative breast cancer (TNBC) is an aggressive subtype with limited targeted treatment among breast cancer subtypes. We identified novel therapeutic candidates; through analyzing 23 GEO datasets comprising 1,712 samples (1,510 tumors 202 controls). Frizzled class receptor 2 (FZD2), a membrane-bound Wnt receptor, was overexpressed in TNBC highlighting its potential as surface-accessible immunotherapeutic target. Using immunoinformatics approaches, we identified key B-cell epitopes through ABCpred, BepiPred 3.0, SVMTriP, and ElliPro, yielding twelve predicted epitopes that were further evaluated for antigenicity, allergenicity, and toxicity with VaxiJen v2.0, AlgPred 2.0, and ToxinPred2. Four epitopes overlapped with existing FZD2 antibodies were taken as control and remaining four epitopes were considered as novel B-cell epitope candidates were subjected for de novo antibody design. De novo antibody design was carried out using RFantibody a computational antibody-design approach used to generate novel antibody candidates against a selected epitope (FZD2). On the basis of four confidence metrics, one highest-scoring designed antibodies for each epitope were retained and carried forward for docking studies to investigate the binding orientation and predicted interaction strength between the designed antibodies and their respective FZD2 epitopes. Among the designed antibody candidates, two exhibited more favourable docking scores and binding affinity than the control antibody. The CAR-T constructs were designed with an antigen-recognition designed scFv, followed by extracellular (CD8), transmembrane regions (CD28) and intracellular signalling components CD3ζ, and truncated IL-2Rβ-associated signalling domain and STAT activating motif. The physico-chemical properties of the designed CAR-T constructs were analysed using the ProtParam tool. The constructs possess good solubility and structural stability, which are important for efficient expression and biological function. The designed CAR-T constructs exhibit desirable physico-chemical properties. The antigenic allergenic, and toxic properties of the designed CAR-T constructs were evaluated to assess their immunological suitability. Both the CAR-T constructs exhibited favourable immunological characteristics. The resulting models were subjected to structural refinement and 300 ns molecular dynamics (MD) simulations using Desmond v7.9 to assess the structural stability and dynamic interactions. Finally, the structural quality of the refined CAR-T constructs were evaluated using ProSA, ProQ, and PROCHECK. The potential of FZD2-targeted fifth-generation CAR-T cells as a promising strategy for the treatment of FZD2-expressing solid tumours. Designed CAR-T cells recognize FZD2 expressed on the surface of solid tumor cells through the scFv domain. Binding of FZD2 activates intracellular CD3ζ and co-stimulatory signaling, leading to T-cell activation, proliferation, and cytokine release.

Keywords: FZD2, CAR-T, GEO, Immunoinformatics, Docking, Immune simulations, MD simulations

Programmable Tetrahedral Dna Nanoarchitectures For Smartphone-assisted Attomolar Detection Of Interleukin-6 In Precision Inflammatory Diagnostics

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Abstract

Interleukin-6 (IL-6) is a multifunctional pro-inflammatory cytokine that plays a central role in immune regulation, inflammatory signaling, and disease progression. Abnormal IL-6 expression has been strongly associated with a broad spectrum of pathological conditions, including autoimmune disorders, infectious diseases, cancer, neurodegenerative diseases, cardiovascular complications, and cytokine storm syndromes. Given its clinical significance, sensitive and rapid quantification of IL-6 is essential for early diagnosis, disease prognosis, therapeutic monitoring, and personalized healthcare. Although conventional immunoassays such as enzyme-linked immunosorbent assays (ELISA) remain widely employed for IL-6 analysis, these methods often require labor-intensive procedures, expensive instrumentation, prolonged assay times, and centralized laboratory facilities, limiting their applicability for decentralized and point-of-care testing .

Herein, we report a smartphone-integrated electrochemical nanobiosensing platform based on programmable tetrahedral DNA nanostructures (TDNs) assembled on gold-printed screen-printed electrodes (Au-SPEs) for ultrasensitive detection of IL-6. The tetrahedral DNA nanostructure was rationally engineered through the self-assembly of four single-stranded DNA sequences to generate a rigid and well-defined three-dimensional nanoarchitecture. Three thiolated vertices of the tetrahedron were anchored onto the gold electrode surface, resulting in an ordered and upright arrangement of the recognition interface. Compared with conventional randomly immobilized probes, the TDN-based architecture provides superior control over probe density and spatial orientation, significantly enhancing target accessibility while minimizing steric hindrance and nonspecific adsorption. Furthermore, the highly organized DNA nanoenvironment promotes efficient electron-transfer kinetics and improves overall sensing performance.

The sensing mechanism relies on the specific interaction between IL-6 and its corresponding recognition element immobilized on the TDN-modified electrode surface. Binding of the target cytokine induces measurable changes in the interfacial electron-transfer resistance, which were monitored using electrochemical impedance spectroscopy (EIS) as a label-free transduction strategy. The integration of programmable DNA nanoarchitectures with highly conductive Au-SPEs generated a sensitive and reproducible electrochemical interface suitable for portable diagnostic applications. The developed nanobiosensor demonstrated exceptional analytical performance, achieving an ultralow limit of detection (LOD) of 5.71 ag/mL and a limit of quantification (LOQ) of 19 ag/mL. A linear response was obtained within the concentration range of 0.0001-0.001 pg/mL, accompanied by a high sensitivity of 104.57 Ω mL/pg/mm2. The sensor further exhibited excellent selectivity toward IL-6 in the presence of potentially interfering biomolecules, together with remarkable reproducibility and long-term storage stability. These results highlight the effectiveness of tetrahedral DNA nanoengineering in constructing high-performance electrochemical biointerfaces for ultrasensitive cytokine monitoring.

Keywords: Tetrahedral DNA Nanostructure (TDN); Interleukin-6 (IL-6); Electrochemical Impedance Spectroscopy (EIS); Point-of-Care Diagnostics; Aptasensor

The Revival of Brucella Cyclic β-(1→2)-Glucan as a Specific Marker for Infection Detection with Elisa

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Abstract

Synthesis And Characterization And Conjugation Of Gold Nanoparticles For Development Of Diagnostic Assay

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Abstract

Identification of various vital body fluid such as blood is important evidence to be recovered from the crime scene during the process of forensic investigation. This is because a very low amount of samples are found at the crime scene. Therefore, the on-spot identification of such body fluids is the major challenge for the forensic investigator. Furthermore, there is a need to design and develop the rapid, sensitive and reproducible methods which could be cost effective. In such a situation, the immunochromatographic techniques are promising. However, these techniques have the limitations in terms of sensitivity. To overcome this issue, the conjugation of nanoparticles with the antibody is highly reliable. Among many types of metal nanoparticles, gold nanoparticles are being highly researched for diagnostics, because of their unique properties.

Considering the potential of gold nanoparticles, the present study is mainly focused on the synthesis and characterization of gold nanoparticles to detect various body fluids including blood from the crime site. For this purpose, we have synthesized gold nanoparticles (AuNPs) of the desired size using a chemical method. The 40 nm AuNPs are usually considered suitable for the development of immunochromatographic assay. Hence, we have optimized different conditions for the synthesis of monodisperse AuNPs. The synthesised nanoparticles were later on characterised by various standard methods such as UV-Vis spectrophotometry, FTIR, XRD, LM20, Zeta Potential, and TEM. Thus, synthesized colloidal AuNPs of 40nm in size showed high stability and colour intensity. Synthesized AuNPs in the colloidal phase has been used for conjugation with mouse originated, monoclonal antibodies for developing highly sensitive and affordable LFA for identification of body fluids, without highly sophisticated instruments. The fully optimised conjugation process and further development of LFA assay has the potential to be used for forensic investigations of low volume samples obtained from crime scene.

Keywords: Gold nanoparticles, Chemical Method, Immunochromatographic, Forensic investigation

Selective Neuronal Nitric Oxide Synthase Inhibitors for Melanoma Treatment

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Abstract

In 2024, an estimated 100,640 new cases of invasive melanoma were diagnosed in the U.S. with 9,290 deaths. Our previous studies revealed that neuronal nitric oxide synthase (nNOS) derived nitric oxide plays a critical role in melanoma progression, making nNOS inhibition a promising strategy. High structural similarity among NOS isoforms requires careful design of nNOS inhibitors to avoid off-target effects. Our previous lead, HH044, demonstrated potent anti-melanoma activities but exhibited only moderate nNOS selectivity. Here, we utilized a structure-based approach to design nNOS inhibitors that promote interactions with hnNOS specific residue His342. Compound 9 exhibited inhibition of both human (Ki = 1.7 nM) and rat nNOS (Ki = 2.3 nM), with 5,654-fold selectivity over human eNOS and 250-fold selectivity over iNOS. X-ray crystallography and molecular modeling revealed a novel SAR, forming the basis for nNOS inhibition and providing a foundation for further innovative design of nNOS inhibitors for melanoma treatment.

Presenter: Amardeep Awasthi, Postdoc, Department of Chemistry, Chemistry of Life Processes Institute, Center for Developmental Therapeutics, Northwestern University, 2145 Sheridan Road, Evanston, Illinois 60208-3113, United States

Computational Frontiers In Aptamer-based Nanomedicine For Precision Therapeutics: A Comprehensive Review

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Abstract

In the rapidly evolving landscape of nanomedicine, aptamers have emerged as powerful molecular tools, demonstrating immense potential in targeted therapeutics, diagnostics, and drug delivery systems. This paper explores the computational features of aptamers in nanomedicine, highlighting their advantages over antibodies, including selectivity, low immunogenicity, and a simple production process. A comprehensive overview of the aptamer development process, specifically the Systematic Evolution of Ligands by Exponential Enrichment (SELEX), sheds light on the intricate methodologies behind aptamer selection. The historical evolution of aptamers and their diverse applications in nanomedicine are discussed, emphasizing their pivotal role in targeted drug delivery, precision medicine and therapeutics. Further, we explore the integration of artificial intelligence (AI), machine learning (ML), Internet of Things (IoT), Internet of Medical Things (IoMT), and nanotechnology in aptameric development, illustrating how these cutting-edge technologies are revolutionizing the selection and optimization of aptamers for tailored biomedical applications. This paper also discusses challenges in computational methods for advancing aptamers, including reliable prediction models, extensive data analysis, and multi-omics data incorporation. It also addresses ethical concerns and restrictions related to AI and IoT use in aptamer research. The paper examines progress in computer simulations for nanomedicine. By elucidating the importance of aptamers, understanding their superiority over antibodies, and exploring the historical context and challenges, this review serves as a valuable resource for researchers and practitioners aiming to harness the full potential of aptamers in the rapidly evolving field of nanomedicine.

Keywords: Aptamers, Nanomedicine, SELEX, Artificial Intelligence, Machine Learning, Computational Modeling, Precision Therapeutics.

CNT@CeO_2 metal-organic framework (MOF) composite acrylic paint for use as an effective antifungal coating material

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Abstract

This research investigates the development of smart acrylic paint en-hanced with cerium oxide (CeO2) nanoparticles combined with multi-walled carbon nanotubes (MWCNTs) to combat the antifungal effects of Aspergillus fumigatus. A. fumigatus is a harmful fungus responsible for invasive aspergillosis, which poses serious health threats, especially to those with weakened immune systems. Traditional antifungal methods, like chlorination, often fail to control its proliferation. To tackle this is-sue, CeO2 nanoparticles (~8 nm) were synthesized hydrothermally on functionalized MWCNTs using a one-pot microwave technique after a mild acid treatment. Different ratios of MWCNTs to CeO2 were opti-mized to achieve the best performance. The resulting nanocomposite was incorporated into an acrylic paint matrix (referred to as nano-paint), and its antifungal properties were assessed through dry weight measurement, UV-visible spectroscopy, FTIR, TEM, and XRD analysis. The findings revealed a substantial inhibition of A. fumigatus growth, with a minimum inhibitory concentration of 0.125 mg/mL. The nanoenhanced acrylic paint demonstrated significantly improved antifungal capabilities com-pared to standard formulations, indicating its potential as a protective coating against fungal contamination. This study highlights that integrating CeO2/MWCNT composites into acrylic paints can enhance antimicrobial effectiveness, durability, and surface characteristics for both medical and industrial uses.

Keywords: Acrylic Paint, Cerium Oxide Nanoparticles (CeO), Multi Walled Carbon Nanotubes (MWCNTs), Antifungal Activity, Aspergillus fumigatus.

Bio-inspired Nanomedicine For Targeted Thrombolysis

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Abstract

Vascular thrombosis, characterised by the pathological obstruction of blood flow by a thrombus, underlies life-threatening conditions including ischaemic stroke and myocardial infarction, accounting for one in four deaths worldwide. Although systemic thrombolytic therapy remains clinically important, its therapeutic efficacy is constrained by short drug circulation times, life-threatening haemorrhagic complications, and limited penetration into dense, platelet-rich thrombi. Nanomedicine strategies capable of concentrating thrombolytic activity within the thrombus while minimising systemic drug exposure therefore offer a compelling approach to safer and more effective intervention.

Here, we present our group's work on targeted thrombolysis, spanning synthetic fibrinogen-mimicking nanocarriers to bio-inspired red blood cell-derived vesicles (RBCVs) for the encapsulation and targeted delivery of thrombolytic drugs. Initial studies demonstrated that functionalising liposomal and chitosan-based nanocarriers with the cyclic arginine-glycine-aspartic acid peptide, cRGD, enabled high-affinity binding to platelet aggregates and promoted drug retention in thrombi under physiological flow. This targeting principle was subsequently translated to top-down engineered RBCVs, generating a dual-targeting platform that combines ligand-mediated platelet binding with the intrinsic biological properties of the red blood cell membrane, including immune evasion, prolonged circulation, and affinity for thrombus components.

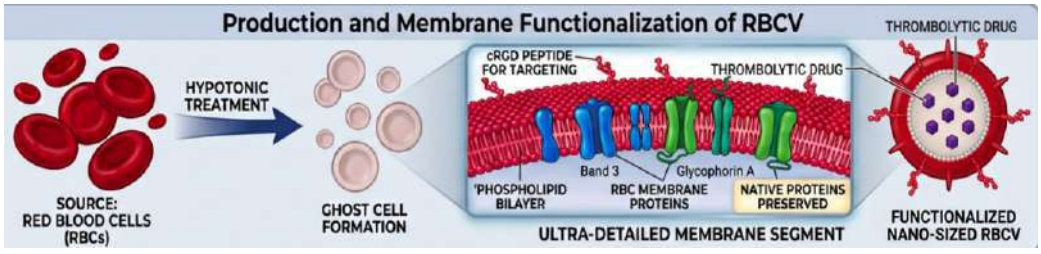


Fig 1 Production and membrane functionalisation of RBCV nanocarriers.

Collectively, these studies establish RBC-derived nanovesicles as versatile and functionally active nanocarriers that enable effective thrombolysis while addressing the major haemorrhagic and half-life limitations of current therapeutic strategies.

Keywords: Precision thrombolysis, Cell membrane-derived nanoparticles, Thrombus-homing, Active clot targeting

From AI-Designed Antivirals to Precision Nanomedicine: Future Therapeutic Strategies against Hemorrhagic Viral Diseases

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Abstract

Hemorrhagic viral diseases caused by pathogens such as dengue virus, Ebola virus, Marburg virus, yellow fever virus, Crimean–Congo hemorrhagic fever virus, and other emerging arboviruses represent a major global health challenge because of their rapid disease progression, vascular dysfunction, thrombocytopenia, immune dysregulation, and limited availability of effective antiviral therapeutics. Current treatment is supportive, while the development of broad-spectrum and pathogen-specific antiviral drugs is constrained by viral diversity, rapid mutation, intracellular replication, tissue tropism, and the complex host responses associated with severe disease. Future drug-designing strategies therefore require integration of structural virology, computational biology, artificial intelligence, multi-omics, molecular dynamics, and precision pharmacology to identify conserved viral and host therapeutic targets and accelerate the development of next-generation antiviral candidates. Emerging approaches will combine AI/ML-assisted virtual screening, structure-based drug design, molecular docking, molecular dynamics simulations, generative drug design, protein–protein interaction analysis, and toxicological prediction to prioritize novel small molecules, peptidomimetics, peptides, nucleic-acid therapeutics, host-directed agents and monoclonal antibodies. Particular emphasis should be placed on viral enzymes and replication complexes, polymerases, entry proteins, proteases, and host pathways regulating endothelial integrity, coagulation, inflammation, and immune responses. In parallel, advanced drug-delivery technologies—including lipid nanoparticles, polymeric nanoparticles, nanocarriers, liposomes, exosomes, dendrimers, microneedles, and stimuli-responsive delivery systems—could improve drug stability, tissue penetration, cellular targeting, and controlled release while reducing systemic toxicity.

Despite advances in supportive care, no universally approved antiviral therapeutics exist for dengue virus, making the identification of druggable targets and development of novel compounds an urgent priority. Among these, the dengue virus with its four serotypes (DENV1–4) presents a unique challenge due to antibody-dependent enhancement (ADE), cross-reactive immunity, and differential disease severity across serotypes. The recurring outbreaks of Dengue across South and Southeast Asia, including India, underscore the need for effective antiviral targeting conserved viral proteins. The main focus of the work is identification of priority drug targets, computational drug screening using phytochemicals and existing antivirals, and computational multi-target therapeutic analysis of dengue fever complicated by diabetes, hypertension, and obesity. Further, a multi-target drug design approach was undertaken to address Dengue infection complicated by diabetes and hypertension. PKC-β was identified as a common pathogenic node across all three conditions, and computational docking identified compounds with favorable binding affinity. Comprehensive toxicity profiling using ProTox 3.0 evaluated organ toxicity, cytochrome interactions, and mutagenicity, lead compounds were subsequently optimized through targeted functional group modification, successfully reducing predicted toxicity while enhancing binding affinity, offering a safer, multi-target therapeutic strategy for high-risk Dengue patients.

Qualitative And Quantitative Determination Of Fungal And Bacterial Infection Glycan Markers Using Sers Spectroscopy And Machine Learning Methods

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Abstract

Invasive fungal and bacterial infections remain a major challenge in modern clinical medicine, particularly among immunocompromised patients. Their rapid progression and high mortality in the absence of timely diagnosis necessitate the development of new approaches for early detection. Conventional diagnostic methods either require prolonged processing times or suffer from limited sensitivity and specificity, as well as susceptibility to false-positive and false-negative results. Under these conditions, Surface-Enhanced Raman Spectroscopy (SERS) has emerged as a promising analytical tool, enabling the detection of analytes at ultra-low concentrations, providing molecular "fingerprints", and significantly reducing analysis time while preserving the native structure of biological samples.

A promising diagnostic strategy involves the detection of pathological conditions through specific oligo- and polysaccharides present in physiological fluids during fungal and bacterial infections. Among these, β-1,3- and β-1,6-glucans are key structural components of the cell wall of many pathogenic fungi and bacteria . An increase in their concentration above threshold levels (~80 pg/mL) serves as an indicator of microbial invasion. Our group has previously demonstrated the feasibility of detecting β-D-galactofuranoside (Galf)-containing structures using SERS ' . The study was performed using synthetic oligosaccharides, which were divided into two classes: (i) Galf-free compounds—oligo-α-(1 2)-Man, oligo-β-(1 3)-Glc, and oligo-β-(1 6)-Glc—corresponding to fragments of fungal α-(1 2)-mannan, β-(1 3)-glucan, and β-(1 6)-glucan, which are components of the cell wall of pathogenic fungi of the genus Candida; and (ii) Galf-containing compounds, including Oligo-GM-Af (related to the antigen of Aspergillus fumigatus), oligo-GI-Kp (related to Klebsiella pneumoniae antigen), and oligo-DHG-Ef (related to Enterococcus faecalis antigen).

Each sample was analyzed at a concentration of 100 pg/mL. The analytes were deposited as 3 μL droplets onto nanostructured silver SERS substrates fabricated by electron-beam deposition according to the protocol described in. This enabled the identification of characteristic vibrational bands distinguishing oligosaccharides with and without Galf residues. The performance of the model was evaluated using precision, recall, and F1-score, all of which reached values of 97%, indicating high reliability. The identification of characteristic Galf vibrational bands further confirms the potential of SERS for detecting species-specific structures of fungi. he present study extends this approach to the analysis of natural polysaccharides and antigens, specifically β-1,3- and β-1,6-glucans, as well as Candida albicans antigen (Ag.C.a.) and Aspergillus fumigatus antigen (Ag.A.f.). Thus, the application of SERS for the detection of polysaccharide markers and species-specific fungal antigens represents a promising strategy for the development of rapid and highly sensitive diagnostic methods for invasive mycoses, with the potential to complement and enhance existing diagnostic approaches.

Keywords: SERS, oligosaccharides, fungi, bacteria, machine learning methods

CDK4 inhibitor palbocilib reduces proliferation and mineralization in MAP2K1+ melorheostosis

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Abstract

Melorheostosis is a rare disease displaying bone overgrowth and exostoses cause deformity and pain. Somatic mutations in MAP2K1 hyperactivate the ERK pathway in osteoblasts, increasing in vitro mineralization. As melorheostosis osteoblasts show increased expression of cell cycle proliferation-related molecules compared to controls, we hypothesized that rapid progression through the cell cycle contributes to the bony overgrowth.

We employed, induced pluripotent stem cell (iPSCs) model from unaffected and affected regions of patient skin fibroblasts. Then differentiated iPSCs into induced mesenchymal stem cells (iMSCs), and later into osteoblasts. A propidium iodide-mediated cell cycle assay revealed that affected iMSCs and osteoblasts have a higher proportion of proliferative cells than unaffected cells. We also recorded that affected cells have elevated expression of phospho-Rb, a master molecule for G1 to S transition. We also recorded higher Ki-67 index in affected iMSCs. Moreover, EdU incorporation assays validated higher percentage of S phase cells in affected populations.

We used the FDA-approved CDK4 inhibitor palbociclib on iMSCs & osteoblasts and found significant reduction of phospho-Rb; increased G0/G1 peak on flow cytometry; and lowered EdU incorporation, which confirms blockade of cell cycle progression by limiting S phase entry. Interestingly, palbociclib treatment for the initial 5 days of total 21 days of osteogenic stimulation restricts mineralization in affected cells to a much greater extent than unaffected cells, confirming that increased proliferation has a role in the bone growth phenotype in patients. Thus overall our data strongly suggest that targeting cell cycle machinery can be promising therapeutic approach for melorheostosis patients.

Molecularly Imprinted Polymer-modified Screen-printed ZNO Nanorod Field-effect Transistors for Serotonin Detection in Clinical Samples

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Abstract

Serotonin (5-hydroxytryptamine, 5-HT) is an important neurotransmitter involved in the regulation of mood, cognition, sleep, and several physiological processes, and its dysregulation has been associated with neurological disorders such as Parkinson's and Alzheimer's diseases. Consequently, ultrasensitive and reliable detection of 5-HT is essential for the early diagnosis and monitoring of these conditions. However, many existing detection strategies rely on sophisticated instrumentation, complex sample preparation, and time-consuming analytical procedures, which limit their suitability for sensitive point-of-care (POC) applications. To address these limitations, this study presents a novel field-effect transistor (FET)-based biosensing platform incorporating direct molecular imprinting of 5-HT on the surface of three-dimensional zinc oxide (ZnO) nanorods integrated with screen-printed electrodes. The molecularly imprinted polymer (MIP) layer provides selective recognition sites complementary to 5-HT in terms of molecular shape and functional groups, while the three-dimensional ZnO nanorod architecture offers a high surface area and an efficient interface for molecular recognition and electrical signal transduction. This strategy enabled ultrasensitive, rapid, and real-time detection of 5-HT in a physiological analyte, achieving an exceptionally low detection limit of 0.1 fM. Furthermore, the use of screen-printed electrodes supports convenient batch fabrication, cost-effective production, and potential sensor miniaturization, making the platform attractive for portable and accessible clinical diagnostics. Importantly, the sensor was evaluated using clinical samples, and its response was correlated with that obtained using the established gold-standard method, with the results found to be statistically similar. These findings demonstrate the reliability and analytical potential of the proposed sensing strategy and highlight its significant promise for translation into clinical settings, particularly for the development of affordable, rapid, and ultrasensitive point-of-care diagnostic devices.

Keywords: Field-effect transistor, ZnO nanorod, Molecularly imprinted polymer, Clinical samples

Fluorinated Isoniazid Derivatives for Improved Efficacy Against Drug-Resistant Mycobacterium tuberculosis

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Abstract

The increasing prevalence of isoniazid (INH)-resistant Mycobacterium tuberculosis poses a major challenge to global tuberculosis control. Resistance is primarily associated with mutations in the **KatG** enzyme, which impair activation of INH from prodrug to drug. Structural modification of isoniazid, particularly through fluorine substitution, represents a promising strategy to enhance anti-tubercular activity and overcome drug resistance. The rationale of the present study was to design fluorinated INH derivatives capable of interacting with the catalytic **Thr315** residue of the **KatG S315T mutant** through hydrogen bonding, thereby preserving KatG-mediated activation of the prodrug. Simultaneously the extent of binding of these fluorinated derivatives with InhA target was analysed. The results showed inhibition of InhA activity as well. InHA is involved in mycolic acid synthesis in M.tb.

Methods: A library of **24 isoniazid derivatives** was designed and evaluated using structure-based computational approaches. The crystal structure of **InhA (PDB ID: 4TRO)** was prepared and subjected to induced-fit molecular docking to investigate ligand interactions within the catalytic pocket. Selected lead compounds were further docked against the **KatG S315T mutant,** where the docking grid was generated by centering on the **Fe atom of the heme prosthetic group,** the catalytic center responsible for isoniazid activation. Drug-likeness and pharmacokinetic properties were evaluated using SwissADME and ADMETlab 2.0. The best-performing protein–ligand complexes were subsequently subjected to **100 ns molecular dynamics (MD) simulations** to evaluate the stability of ligand binding and conformational behavior under physiological conditions.

Results: Several fluorinated derivatives demonstrated markedly improved binding affinities compared with native isoniazid **(−6.7 kcal/mol)** against InhA. The **Isoniazid–Linezolid hybrid** exhibited the strongest binding affinity **(−14.0 kcal/mol),** followed by fluorinated piperazine derivatives with docking scores of **−12.6** and **−11.7 kcal/mol.** Additional fluorinated analogues displayed binding affinities ranging from **−10.4 to −8.3 kcal/mol,** highlighting the beneficial effect of fluorine substitution on target recognition. Selected lead compounds also exhibited favorable binding toward the **KatG S315T mutant,** including Isoniazid–Acetazolamide and Compound 22 (−7.3 kcal/mol), Compound 13 (−6.7 kcal/mol), Compound 15 (−6.5 kcal/mol), Compound 12 (−6.2 kcal/mol), and Compound 19 (−5.7 kcal/mol), establishing interactions with the catalytic residues Arg104, Trp107, His108, Asp137, Tyr229, Met255, His270, Thr315, Trp321, and Arg418. Most derivatives complied with Lipinski's Rule of Five and exhibited favorable gastrointestinal absorption, blood-brain barrier permeability, and overall drug-like characteristics. Furthermore, MD simulations of the highest-ranked complexes demonstrated stable protein–ligand interactions throughout the simulation period, supporting the structural stability and binding persistence of the selected lead molecules.

Conclusion: The present study demonstrates that fluorinated isoniazid derivatives possess enhanced binding affinity toward both **InhA** and the clinically relevant **KatG S315T mutant,** highlighting their potential to overcome isoniazid resistance. The integration of molecular docking, ADMET profiling, and molecular dynamics simulations identified several promising lead candidates for further synthesis and biological evaluation, providing a strong framework for the development of next-generation anti-tubercular therapeutics against drug-resistant Mycobacterium tuberculosis.

Keywords: InhA; Induced-fit molecular docking, ADMET

Pgc1 Alpha Agonist Loaded Garlic Derived Exosome Like Nanoparticles Rescues Doxorubicin Induced Cardiomyopathy

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Abstract

Dilated Cardiomyopathy (DCM) significantly contributes to development and progression of heart failure (HF) and inflammatory milieu further exacerbate the disease symptoms. Morphological and functional defects of heart in doxorubicin (Dox) induced cardiac injury are similar to those of DCM. Garlic derived exosome like nanoparticles (GELNs) possess the inherent anti-inflammatory, anti-oxidant and regenerative potential and offers a unique drug delivery system. The PGC-1α (PPAR-γ coactivator-1α) agonist that is considered as the 'master regulator' of mitochondrial biogenesis and can rescue the Dox induced DCM by modulating the metabolic reprogramming. This study aimed to evaluate the therapeutic effect of PGC-1α agonist loaded GELNs (pGELNs) in rescuing the Dox induced DCM phenotype. Thirty-two male C57BL/6J mice (8 weeks old), divided in four groups (n=8 per group) i.e. Control (Vehicle treated), Dox, Dox + PGC-1α agonist, Dox + GELNs, and Dox + pGELNs. The Dox group received Dox (10 mg/kg single dose) to induce DCM like phenotype (in 15 days) characterized by marked morphologic alteration in cardiac tissue and echocardiography parameters along with ultrastructure changes. Significant increased staining observed for Masson Trichome/Picrosirius red and α-SMA that indicated enhanced fibrosis in Dox group compared to control group. Further, increased NETosis, necroptosis and impaired autophagy have been observed in Dox group compared to controls. When Dox treated group was administered with GELNs (30microgram/mice, 4 doses every alternate days) or pGELNs (4 doses of 30 microgram/mice of GELNs,; PGC-1α agonist, total cumulative dose = 10mg/kg (2.5mg/kg/dose) every alternate days) significant improvement ($p < 0.05$) has been observed in cardiac architecture along with restoration of ultrastructure, preservation of echocardiographic parameters, marked decrease in extent of fibrosis, decrease in NETosis and necroptosis, increase in autophagy and it was comparable to control group. However, the magnitude of improvement is potentiated in pGELNs group compared to GELNs group.

This study defined the therapeutic effect of GELNs and pGELNs on various biological process like autophagy, NETosis and necroptosis along with demonstrating the utility of plant derived exosome like nanoparticles (PELNs) as a robust drug delivery system. Collectively, study demonstrated the cardioprotective effect of GELNs and pGELNs that mitigated the Dox induced cardiotoxicity and preserved the DCM phenotype.

Keywords: Pgc1 Alpha, Garlic Derived Exosomes, Mitochondria, M-mode Echocardiography, Necroptosis, Netosis/nets (neutrophil Extracellular Traps), Maximum 7 Words, Times New Roman, Font Size 10, Italic

Structural Characterization and In Vitro Anticancer Activity Of Biogenic $NIFE_2O_4$ Nanoparticles

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Abstract

Nickel ferrite ($NiFe_2O_4$) Nanoparticles were prepared using a green co-precipitation method with a natural reducing and stabilizing agent of Crocus sativus flower petal extract. The synthesis was performed by the controlled co-precipitation of nickel and iron precursors with the plant extract, followed by drying and calcination to obtain $NiFe_2O_4$ nanoparticles. The green synthesis method minimizes the use of toxic chemicals and offers an environmentally friendly method to synthesize nanoparticles. The synthesized nanoparticles were highly crystalline with an average crystallite size of about 29.8 nm and a predominantly cubic spinel $NiFe_2O_4$ structure. The morphological analysis showed that the nanoparticles were almost spherical and moderately aggregated. The synthesized nanoparticles exhibited concentration-dependent in-vitro anticancer activity against human lung carcinoma (A549) cells with an IC_{50} value of 51.23 µg/mL as determined using the MTT assay. In comparison, relatively high viability (> 85%) was maintained in normal HEK293 cells at 100 µg/mL, which is evidence of good cytocompatibility and selective biological response. The exact mechanism of anticancer activity was not directly studied in the present study, and further mechanistic studies are needed. Overall, the study demonstrates the successful green preparation of nanocrystalline $NiFe_2O_4$ nanoparticles with potential anticancer activity.

Nanohybrid Electrochemical Biosensor Based on Molecularly Imprinted Polymer and Bismuth-Doped Copper Ferrite for Point-of-Care CRP Analysis

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Abstract

Early identification of infections, systemic inflammatory diseases, and cardiovascular abnormalities relies on the rapid and ultrasensitive detection of C-reactive protein (CRP), a clinically relevant inflammatory biomarker. Presence of high-performance electrochemical biosensor for the selective measurement of CRP in human blood based on Molecularly Imprinted Polymer (MIP)-Bismuth-doped Copper Ferrite (Bi(0.10)CuFe O) nanoparticle nanohybrids has been studied. The MIP layer provides molecular-level identification of CRP via specially created binding cavities, while the Bi-doped Copper ferrite nanoparticles give higher electrical conductivity, increased redox activity, and a large surface area, it is characterised via XRD, FTIR, UV, SEM, EDX, HR-TEM/TEM. Sensing and optimisation by using electrochemical impedance study (EIS), cyclic voltammetry (CV), and Differential pulse voltammetry (DPV). CRP biomarkers may be detected within the linearity range of 0.5 ng/mL to 100 ng/mL, with sensitivity values of 3.7406 Ω/ng cm². The LOD, as determined by electrochemical analysis, is 0.025 ng/mL of analyte CRP.

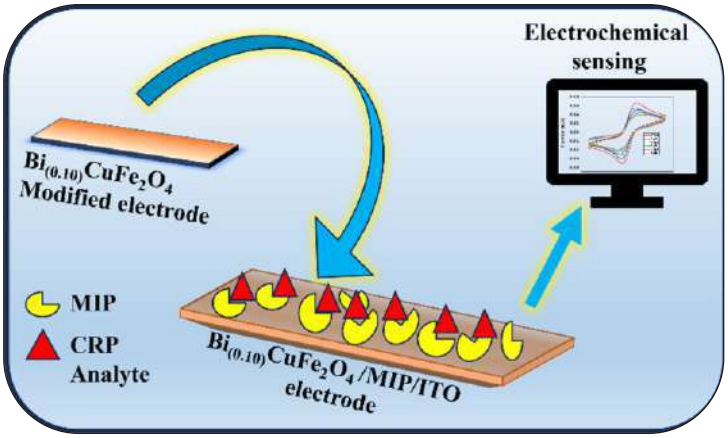


Figure- Graphical abstract image

Keywords: Molecularly imprinted polymer, Bi-doped Copper ferrite, electrochemical impedance study, C-reactive protein, cardiovascular disease, nanoparticles

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Dynamic Peptide Nanomaterials: From Adaptive Mechanics And Self-healing To Bone-mimetic Regenerative Matrices

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Abstract

The extracellular matrix (ECM) is a dynamic and adaptive microenvironment in which structural organization, mechanical properties, and biochemical cues collectively regulate tissue function and regeneration. Developing synthetic nanomaterials that recapitulate these dynamic characteristics remains a major challenge in regenerative nanomedicine. Our research explores self-assembled peptide-based nanomaterials as versatile platforms for engineering bioinspired and mechanically adaptive matrices. We developed pathway-driven peptide–bioglass nanocomposites exhibiting dynamic and self-healing characteristics, demonstrating their potential as bioactive regenerative matrices. Building upon this concept, controlled mineralization of self-assembled peptide nanofibers was employed to generate mechanically stiffened and self-healable composites with features resembling the bone ECM. In parallel, nanofibrous peptide–polymer conjugates were engineered to exhibit on-demand strain stiffening inspired by the adaptive mechanics of actomyosin networks. Collectively, these studies demonstrate how peptide self-assembly, biomimetic mineralization, and dynamic mechanical regulation can be harnessed to create multifunctional nanomaterials, providing a versatile framework for developing next-generation biomimetic materials for regenerative nanomedicine and tissue engineering.

Keywords: Peptide nanomaterials, Self-assembly, Regenerative nanomedicine, Self-healing biomaterials, Bone-mimetic nanocomposites, Adaptive mechanics

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Fishing For Bacteria: An Insect LysM Protein Platform for High-throughput Capture and SERS Identification

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Abstract

Rapid and selective detection of bacterial pathogens in clinical and food matrices remains a significant challenge, particularly when downstream phenotypic or metabolic characterization of intact, viable cells is required. Antibody-based capture agents offer high specificity but are limited to predefined target strains, while antimicrobial peptides provide broad-spectrum binding at the cost of membrane disruption and cell lysis, precluding further biological analysis. We describe an integrated two-stage analytical platform that combines broad-spectrum, non-toxic bacterial capture using a recombinant insect-derived LysM domain protein with SERS-based metabolic profiling of purine derivatives released from the captured cells, using silver nanoparticles (AgNPs) as the SERS substrate.

The capture component is based on a recombinant fusion protein, EGFP-LysM, consisting of enhanced green fluorescent protein (EGFP) and the peptidoglycan-binding LysM motif derived from the turnip white butterfly *Pieris rapae*. In contrast to previously characterized LysM domains of bacterial or phage origin, this insect-derived module functions as a pattern recognition receptor in innate immunity, providing inherent broad-spectrum affinity for the peptidoglycan layer common to both Gram-positive and Gram-negative bacterial cell walls. The EGFP-LysM fusion protein was recombinantly expressed in *E. coli* using two independent expression systems (pET-28b/Tuner DE3 and pQE30/TG-1) and purified by Ni-NTA affinity chromatography. Comparative evaluation of denaturation and refolding protocols established that extraction under mild denaturing conditions (2 M urea) preserved significantly higher fluorescence activity relative to extraction under fully denaturing conditions (8 M urea), indicating a greater proportion of correctly folded protein. Purification yields reached up to 80 mg per liter of culture at a purity exceeding 97%.

Passively adsorbed onto standard polystyrene microplates, EGFP-LysM captured both Gram-positive (*S. equorum*) and Gram-negative (*E. coli*) bacteria with relatively high efficiency. Subsequent growth and proliferation assays confirmed that the captured cells retained full viability, demonstrating that the LysM-mediated binding mechanism does not compromise cell membrane integrity. This non-toxic capture is a functional requirement of the platform: following surface capture and removal of unbound material by washing, the retained bacteria were incubated in deionized water to induce osmotic stress-driven efflux of intracellular metabolites. The resulting cell-free supernatant, enriched in purine derivatives, was then used directly for SERS analysis.

Purine derivatives – adenine, guanine, hypoxanthine, xanthine, uric acid, and adenosine monophosphate (AMP) – are established indicators of bacterial metabolic activity and have been associated with antibiotic resistance phenotypes. AgNPs synthesized by the hydroxylamine reduction method were employed as SERS substrates, with spectra recorded at 785 nm excitation.

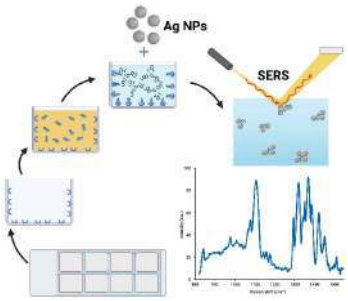


Fig. 1. Principal scheme of developing pipeline based on LysM protein and SERS analysis of captured bacteria metabolites.

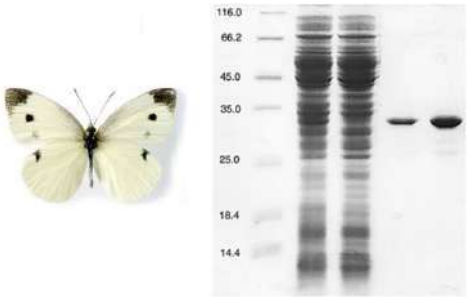


Fig. 2. Electrophoretic separation of soluble protein fractions obtained during the isolation and purification of the recombinant 6His-EGFP protein (lanes 4 and 5).

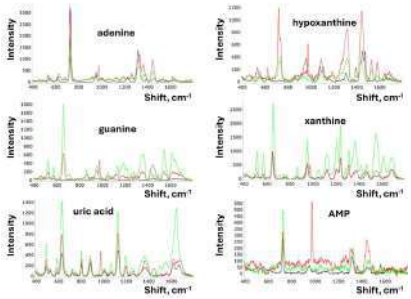


Fig. 3. SERS spectra of purine derivatives recorded under optimized conditions: adenine, hypoxanthine, guanine, xanthine, uric acid, AMP. Black – 750 mM NaCl, red – 1000 mM Na_2SO_4, green – 40 mM $NaNO_3$.

The effect of aggregating agent identity (NaCl, $NaNO_3$, CH_3COONa, Na_2SO_4) and concentration (0-1000 mM) on SERS signal intensity was systematically evaluated at pH 6.4. Signal intensity and analyte selectivity varied substantially across conditions, attributable to differences in the specific adsorption affinity of the respective anions for the AgNP surface and their competitive or cooperative interactions with the purine analytes. Three measurement conditions were identified as optimal for selective profiling of distinct purine subsets: 750 mM NaCl, 1000 mM Na_2SO_4, and 40 mM $NaNO_3$. Parallel application of these three conditions to a single sample enables multiplexed discrimination of individual purine species from a complex metabolite mixture.

The described platform integrates recombinant protein engineering for selective, viability-preserving bacterial concentration with AgNP-based SERS for sensitive metabolic fingerprinting of the captured cell efflux. This workflow provides a technically straightforward, scalable approach to pathogen identification and antibiotic resistance profiling applicable to clinical diagnostics and food safety monitoring.

Keywords: LysM domain, bacterial capture, Ag nanoparticles, Surface-Enhanced Raman Scattering (SERS), peptidoglycan recognition, antibiotic resistance profiling

Funding: This work was supported by the Ministry of Science and Higher Education of the Russian Federation (FFZR–2024–0005, agreement No. 075-00422-24-02 dated May 28, 2024).

Cytosol-targeted Dendronized Mirna Nanovesicles Induce Exercise-mimetic Effects for Obesity Treatment in A Preclinical Mouse Model

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Abstract

Sedentary lifestyle results upregulation of PPARγ expression (key transcriptional factor of adipogenesis) in obesity. Obesity is a chronic illness with multiple contributing factors, brought on by a number of physiological and environmental variables. The primary cause of the condition cannot be treated by current treatment modalities as they treat obesity either by increasing feelings of satiety or by suppressing appetite. Thus, in order to cure obesity, we need a medication that acts at the molecular level. Gene therapy is demonstrating encouraging outcomes in the molecular treatment of a number of disorders. In order to target adipose tissue and reduce off-target effects, this study looks into optimizing targeted nanoformulation of RNAi therapeutic. This miRNA-based formulation will silence the PPARγ to treat the obesity at molecular level. But endosomal trapping and degradation of RNAi therapeutic limits the scope of RNAi therapy. Therefore, in this investigation we have explored the combination of dendrimer-IL as an effective machinery for the cytosolic delivery and endosomal escape. Dendrimer was first complexed with RNAi, which resulted in further loading into aqueous core of nanoformulation. The gel retardation assay was used to optimize the ratio of RNAi complex with the dendrimer. Subsequently, nanoformulation was prepared using thin-film hydration technique, followed by size reduction via extrusion. Higher RNAi entrapment efficiency was achieved by spherical nanoformulation and endosomal escape assay using Flow cytometry revealed better escape. Developed nanoformulation satisfy in vitro safety requirements with hemolysis assay and cytotoxicity assay. The in vivo safety of nanoformulation was further confirmed by hematological and histopathological criteria. The effectiveness of nanoformulation for anti-obesity effects was demonstrated by pharmacodynamic measures, such as decreased body weight, organ weight, better lipid profiling, and changed obesity mRNA and protein markers. Outcome advocates curative fast effective long-term benefits in treating obesity.

Keywords: miRNA, Dendrimer, Nanovesicles, RNAi, Ionizable lipid

Conducting Textile Based Electrochemical Device: An Innovative Platform for Early Oral Cancer Detection

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Abstract

Herein, we successfully fabricated a cost-effective and eco-friendly thread-based electrochemical biosensor for the simultaneous detection of CYFRA-21-1, enabling early diagnosis of oral cancer. The key innovation lies in utilizing household cotton thread (CT) as an electrode substrate, modified with poly(3,4-ethylenedioxythiophene):poly (styrenesulfonate) (PEDOT:PSS) conductive ink, followed by the integration of a well-established carbonaceous allotrope, carbon nanotubes (CNTs).

This modification improved the electrochemical efficiency and enhanced the stability of the PEDOT:PSS coating on the cotton thread. For the fabrication of the biosensing electrode, monoclonal antibodies of CYFRA-21-1 were immobilized, followed by bovine serum albumin (BSA) as a blocking agent. The nanomaterials and the fabricated electrode were characterized using X-ray diffraction (XRD), scanning electron microscopy (SEM), attenuated total reflectance (ATR), and electrochemical techniques. The electrochemical response of the fabricated biosensing electrode (BSA/anti-CYFRA-21-1/CNT/PEDOT:PSS/CT) was recorded against CYFRA-21-1 protein using chronoamperometry (CA). The biosensor exhibited excellent sensitivity of 98.79 μA $[\log(\text{ng mL}^{-1})]^{-1}$ cm^{-2}, with a linear detection range of 0.001 ng mL^{-1} to 70 ng mL^{-1} (R^2 = 0.98). Furthermore, it demonstrated a remarkably low limit of detection (LOD) of 0.0005 ng mL^{-1} and a shelf life of up to 21 days. The developed biosensor was also evaluated in artificial saliva samples, showing a strong correlation with standard samples.

Keywords: Biosensor; carbon nanotubes; thread-based electrochemical biosensor; CYFRA-21-1: Diagnostics

Integrating Green Nanotechnology And Ayurveda For Cancer Supportive Care: A Translational Framework

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Abstract

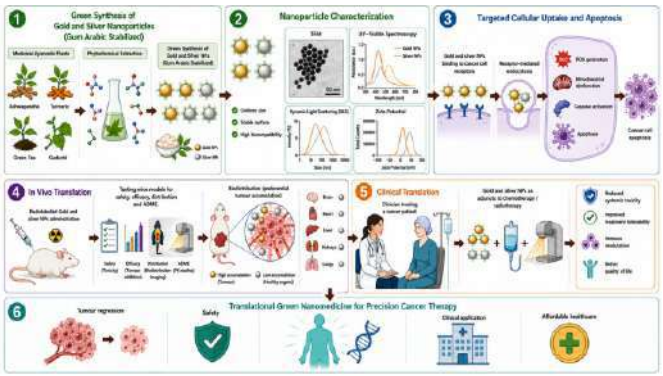
Conventional cancer therapies such as chemotherapy and radiotherapy face limitations including systemic toxicity, resistance, and reduced quality of life. Integrative oncology by merging evidence-based complementary systems like Ayurveda with standard care address these limitations holistically.

Objective: To present a translational framework integrating nanotechnology with Ayurvedic bioactives to enhance treatment tolerability, resilience, and patient well-being during cancer therapy.

Methods: Gold and Silver nanoparticles (Au/AgNPs) were synthesized using Ayurvedic phytoconstituents such as mangiferin, EGCG (epigallocatechin gallate), and naringenin, stabilized with Gum Arabic. These green nanoformulations were characterized and evaluated in vitro for cytotoxicity, receptor-mediated internalization, and apoptosis. Radiolabeled versions (GA-198AuNPs, MGF-AuNPs) were tested in animal models to assess biodistribution, tumor retention, and systemic safety.

Results: Green Nano-Ayurveda formulations demonstrated high tumor selectivity, over 80% tumor regression in preclinical models, and minimal off-target toxicity. Preliminary clinical applications explored their role as adjunctive agents alongside chemotherapy or radiotherapy, focusing on immune modulation, symptom control, and metabolic support. Outcomes included improved patient-reported measures (e.g., fatigue, nausea, pain), inflammatory marker modulation, and enhanced therapy tolerability.

Conclusion: Green nanotechnology Ayurveda offers a novel, biocompatible, and translationally viable platform for integrative cancer therapy. By combining traditional bioactives with modern delivery systems, this approach holds promise for improving patient outcomes. Green synthesized gold and silver nanoparticle formulations derieved from Ayurvedic phytochemiclas represent a scalable and potentially cost-effective nanomedicine platform for targeted cancer therapy. However, clinical validation through well-designed trials remains essential. Conflict of Interest: The authors declare no conflicts of interest.



Translational pathway of green-synthesized gold and silver nanoparticles for precision oncology, from plant mediated nanoparticle synthesis and characterization to targeted cancer therapy, preclinical validation, clinical translation and improved therapeutic outcomes.

Keywords: Nanomedicine, nanoparticles, green synthesis, cancer therapy, Ayurveda, drug delivery, phytochemicals

A Non-invasive Saliva-based Optical Biosensor For Point-of-care Glucose Monitoring

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Abstract

Non-invasive glucose monitoring remains a critical unmet need for improving patient compliance in diabetes management. Here, we present a clinically validated, portable saliva-based optical biosensing platform that integrates optimized sensing chemistry, microfluidic strip engineering, and embedded electronics for point-of-care applications.

The biosensor employs a 3D-printed microfluidic strip with a cellulose-based sieving matrix, enabling controlled capillary-driven transport of saliva while filtering interferents. Glucose detection is achieved via a bienzymatic glucose oxidase–peroxidase (GOD–POD) system coupled with the chromogenic dye *o-Dianisidine*, producing a quantifiable colorimetric response proportional to salivary glucose concentration. Iterative improvements in sensing chemistry—from pH-dependent systems to interference-resistant chromogenic reactions—significantly enhanced specificity and robustness.

Importantly, *o-Dianisidine* offers clear advantages over conventional chromogenic systems such as ABTS and 4-aminoantipyrine (4-AAP)–phenol. Unlike ABTS, which forms a soluble radical cation susceptible to reduction by salivary interferents and diffusion-related variability, *o-Dianisidine* undergoes direct peroxidase-mediated oxidation with localized color formation, enhancing signal stability within the microfluidic matrix. Compared to 4-AAP–phenol systems, which rely on coupled reaction pathways sensitive to reaction kinetics, *o-Dianisidine* enables faster and more reproducible signal generation.

The integrated handheld device incorporates an optically isolated LED–RGB detection module, eliminating ambient light interference and enabling real-time analysis. The platform demonstrates a broad detection range (~14.5–225 mg/dL) and rapid response.

Clinical validation revealed strong correlation with blood glucose (R^2 up to ~0.99), satisfying Clarke's error grid criteria. In addition, Bland–Altman analysis demonstrated good agreement between salivary glucose-derived values and commercial blood glucometer readings, confirming analytical reliability of the developed platform.

This work represents a paradigm shift from invasive finger-prick testing to a painless, cost-effective, and user-friendly saliva-based monitoring approach, addressing ASSURED criteria for point-of-care diagnostics. The proposed biosensor holds significant potential for mass screening, continuous self-monitoring, and deployment in resource-limited settings, particularly benefiting populations with needle phobia.

Keywords: Salivary glucose monitoring, Optical biosensor, Point-of-care diagnostics, Colorimetric detection

Beyond the Skin Barrier: Microneedles for Next-generation Transdermal Biosensing

Dr. Sachin Kadiyan

Manipal University, India

Abstract

Biological Degradation of Graphitic Carbon Nitride Sheets and Autophagy Induction in Macrophages

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Abstract

The discovery of graphene has led to the exploration of numerous two-dimensional materials (2DM) increasingly used in industrial and biomedical applications. However, nano-safety and biological degradation are poorly understood.1 Recently, the metal-free 2DM, graphitic carbon nitride (g-C3N4), has gained attention for its optical properties and potential applications in cancer therapies and bioimaging due to its low toxicity and fluorescence. In this regard, investigating the biodegradability of such materials will be crucial for understanding their in vivo fate and for designing potential biomedical applications.2,3 Hence, we studied the biodegradability of two types of g-C3N4 nanosheets (exfoliated and porous) using human myeloperoxidase (hMPO, from neutrophils), plant enzyme HRP (horseradish peroxidase) and photo-Fenton reaction (PF, generating hydroxy radicals).4 The biodegradation was followed by microscopic and spectroscopic techniques such as TEM, Raman, X-ray photoelectron, UV-vis and fluorescence spectroscopy. All these results confirmed that the g-C3N4 sheets could be degraded better by human enzyme (hMPO) over plant enzyme, HRP. Porous sheets showed higher degradability than exfoliated g-C3N4 sheets due to the presence of oxygen groups obtained during pre-acid treatment. Next, the PF reaction was performed to interrogate the degradation by-products using mass spectrometry, and the cytotoxicity of degradation products was assessed in comparison with pristine g-C3N4. Further, the impact of g-C3N4 on the induction of autophagy in the RAW264.7 macrophages was confirmed by over-expression of the autophagy marker, LC3 protein, significantly observed for the porous sheets. Finally, the immunomodulatory function of the nanosheets and cytokine production was also evaluated in RAW macrophages, demonstrating that the porous nanosheets induced a dose-dependent pro-inflammatory response. Autophagy induction highlights the potential use of g-C3N4, which could be applied in cancer therapies to induce suppressed autophagy.

Keywords: Graphitic carbon nitride, biodegradation, autophagy, cytokine production

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Computational Elucidation of Metal–Ligand Interactions in Fe-BDC, Cu-BDC and Ni-BDC Frameworks: Structure–Property Relationships and Prospects for Nanomedicine

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Abstract

Metal–organic frameworks (MOFs) are promising nanoplatforms for biomedical applications because of their tunable metal–ligand chemistry, accessible surface areas and potential for stimulus-responsive cargo delivery. This study presents a comparative computational investigation of Fe-BDC, Cu-BDC and Ni-BDC coordination frameworks to elucidate how the metal centre influences coordination geometry, electronic structure and stability. Using benzene-1,4-dicarboxylate (BDC) as a common linker, the study systematically evaluates the role of Fe, Cu and Ni in determining framework properties.

Density functional theory (DFT) calculations are employed to examine optimized structural parameters, coordination environments, frontier molecular orbitals, HOMO–LUMO characteristics, charge distribution and relevant energetic descriptors. Comparative analysis of metal–oxygen interactions is used to establish structure–property relationships and assess electronic communication between the metal centres and the aromatic dicarboxylate linker. Particular attention is given to descriptors associated with framework stability and redox responsiveness, which are relevant to the design of nanoscale biomedical platforms.

The computational findings are further considered in the context of emerging nanomedicine applications, including controlled drug delivery, targeted therapy, imaging and stimulus-responsive treatment. Understanding the electronic effects of metal-node substitution may therefore provide a rational basis for selecting metal centres and designing MOF architectures with application-specific properties.

Keywords: Metal–organic frameworks; Fe-BDC; Cu-BDC; Ni-BDC; DFT; metal–ligand interactions; HOMO–LUMO; nanomedicine

Development and Characterization of Chitosan- Cyclodextrin Microparticles of Nifedipine

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Abstract

Nifedipine, a calcium channel blocker used for hypertension and angina, suffers from poor aqueous solubility, which limits its dissolution and, in turn, its oral bioavailability. Polymeric and cyclodextrin-based delivery systems are one way to address this, since they can alter a drug's apparent solubility and control how it's released over time without changing the drug molecule itself. This study developed chitosan-cyclodextrin microparticles loaded with nifedipine, using cyclodextrin to form a host-guest inclusion complex that boosts apparent solubility and dissolution. The hydrophobic nifedipine molecule sits inside the cyclodextrin's cavity, while its more hydrophilic outer surface interacts with water, effectively masking the drug's poor wettability. Chitosan was chosen as the carrier because it's biocompatible, biodegradable, and mucoadhesive, properties that make it useful not just for encapsulation but for prolonging contact time in the gut and providing a more sustained release than the drug alone would give. The nifedipine-cyclodextrin complex was prepared by solvent evaporation, then incorporated into chitosan microparticles through emulsion crosslinking, typically using Sodium Tripolyphosphate (STPP) as a crosslinker to stabilize the polymer matrix. The resulting particles were evaluated across several parameters: particle size and morphology, percentage yield and drug content, and entrapment efficiency. Solid-state characterization used FTIR to detect any chemical interactions between drug, cyclodextrin, and polymer, DSC to track changes in the drug's melting behavior and crystallinity, and powder XRD to confirm whether the drug retained its crystalline form or converted to an amorphous state within the complex. In vitro release testing rounded out the evaluation, showing how the drug is released from the microparticles over time under simulated physiological conditions. The underlying question is how complexation and polymeric encapsulation, working together, affect nifedipine's physical state and dissolution behavior. If the combined system performs as intended, it should improve the drug's dispersion and dissolution rate while also giving it a more controlled release profile than either the cyclodextrin complex or chitosan matrix could achieve on their own. That combination, faster initial dissolution paired with sustained release, is the practical appeal for oral dosing, since it could mean better absorption without needing more frequent dosing. Confirming whether this translates into a real bioavailability benefit, though, would require more work beyond this characterization study: further formulation optimization, and eventually in vitro-in vivo correlation studies to establish whether the dissolution improvements seen in the lab actually hold up in a biological system.

Keywords: Nifedipine; Chitosan; Cyclodextrin; Microparticles; Drug delivery; Solubility; Controlled release

Nanoliposomal Delivery of Tea Bioactives Across The Bbb

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Abstract

The blood-brain barrier (BBB) represents a major physiological obstacle to the delivery of bioactive compounds to the brain, limiting the therapeutic potential of many naturally occurring phytoconstituents. Tea is a rich source of bioactive molecules with diverse pharmacological properties; however, their application in biomedical systems can be constrained by limited bioavailability, cellular toxicity at higher concentrations and restricted access to the brain. In the present study, nanoliposomes were developed as a nanocarrier system for the delivery of selected tea phytoconstituents (gallic acid, caffeine, chlorogenic acid, quercetin, EGCG, and theaflavin) with particular emphasis on their BBB permeability and cytotoxic profiles.

Nanoliposomes were prepared via thin-film hydration using phosphatidylcholine and cholesterol, forming stable bilayer vesicles. Characterization of nanoliposome-coated tea components was done by Dynamic Light Scattering (DLS), Zeta potential, and TEM (Transmission electron microscopy). Gallic acid, caffeine, chlorogenic acid, quercetin, EGCG, and theaflavin were incorporated into nanoliposomes and evaluated for their encapsulation efficiency, physiochemical characteristics, cellular responses and potential to interact with the BBB. Nanoliposomal encapsulation substantially influenced the biological profiles of the investigated phytoconstituents. Cytotoxicity was evaluated using the MTT assay at concentrations ranging from 100-500 mM. EGCG and caffeine exhibited favorable cytocompatibility, whereas chlorogenic acid, theaflavin, and quercetin showed concentration dependent cytotoxicity. Incorporation into nanoliposomes altered the cytotoxic profiles of the phytoconstituents with IC50 values shifting by more than two-fold, demonstrating the ability of the nanocarrier system to modulate their cellular effects. BBB permeability was further investigated using DAPI fluorescence and HPLC-based analysis of zebrafish braims. Gallic acid demonstrated the highest brain uptake, while caffeine showed moderate uptake and theaflavin and quercetin exhibited comperatively low uptake. Nano liposomal encapsulation substantially improved the delivery characteristics of the tea phytoconstituents, producing up to a 10-20-fold enhancement in BBB-associated brain uptake and reducing cytotoxicity by more than 50%. The findings demonstrate that nanoliposomes can serve as an effective delivery platform for tea-derived bioactives and provide a strategy for improving their suitability for brain-directed applications. The observed modulation of cytotoxicity following encapsulation further highlights the importance of nanocarrier-mediated delivery in optimizing the biological activity and safety of plant-derived compounds. The study provides a basis for the development of tea phytoconstituent based nanotherapeutics and supports the potential application of nano liposomal systems in BBB-oriented drug delivery.

Keywords: Nanoliposomes, Tea bioactives, Blood-brain barrier, Nanocarrier, Drug delivery, Cytotoxicity

Cervicare: Advancing Nanotechnology-enabled Point-of-care Diagnosis For Cervical Cancer

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Abstract

Cervical cancer, predominantly caused by High-Risk Human Papillomavirus (HR-HPV) type 16, remains a formidable global health challenge due to its high mortality rates. Despite medical advancements, traditional cervical cancer detection methods suffer from inefficiencies and cost limitations. To address this critical need, our study focuses on the development of an innovative electroanalytical DNA-based biosensing device using Ti3C2Tx/DNA hybrid screen-printed paper electrode strips for the detection of HPV-16. Comprehensive characterization techniques including X-Ray Diffraction (XRD), Field Emission Scanning Electron Microscopy (FESEM), Fourier Transform Infrared Spectroscopy (FTIR) and UV-Visible Spectroscopy (UV-Vis) have been used to provide insights into the Ti3C2Tx nanosheet structure, surface morphology, functional groups and optical bandgap. The genosensing platform demonstrates highly sensitive detection capabilities towards HPV-16. Analysis and calibration using Cyclic Voltammetry exhibits an ultralow Limit-of-Detection (LoD) of 2.4 fM for HPV-16 target DNA. Integration of the developed screen-printed paper-based electrodes with miniaturized electronics and 3D printing technology resulted in the creation of the point-of-care device named as Cervicare; which is a portable, sustainable and user-friendly solution for affected patients. This in-house developed device was calibrated to a LoD of 0.02 pM for HPV-16 detection, along with preliminary validation on patient samples, which exhibits promise for point-of-care diagnostics especially in remote areas. Cervicare represents a significant leap forward towards cervical cancer diagnosis. By providing a rapid, accurate and affordable diagnostic solution, it holds the potential for early detection and improved disease management. Its practicality and suitability for resource-constrained settings make it a powerful tool in enhancing healthcare accessibility in the future, by fitting well with the tenets of Viksit Bharat 2047, Make-in-India, Atmanirbhar Bharat and various Sustainable Development Goals (SDGs).

Keywords: Cervical Cancer, HPV-16, Ti3C2Tx MXene, Electrochemical Transduction, Point-of-care Device, Affordable & Sustainable Healthcare

Design And Utilization Of Virus-like Particle Nano-platform for Pandemic Preparedness and One Health Approach

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Abstract

Public health is challenged by emergence of evolving zoonotic pathogens, that threatens global health security, as evident in recent outbreaks of Corona, Nipah, Hanta and Ebola viruses. Pandemic preparedness against an X disease, necessitates a rapid timely response for pathogenic strain identification, surveillance, diagnosis, development of therapeutics, vaccines, etc. Virus-like particles (VLPs), a multipurpose nanotechnology, is not only well suited to address these challenges but also help investigate the deadliest pathogens in less virulent forms in BSL2 facilities. Nano-VLPs being genome deficient are non infectious but present a highly immunogenic surface that is amenable to genetic/chemical modification for displaying multiple epitopes. This nanotechnology platform is already deployed in licensed vaccinations for HBV, HPV, etc. Its plug and play versatility and adaptability allows faster development of diagnostics, therapeutics, biosimilars and vaccines during public health crisis. Nano-VLP platform is tunable, highly scalable and cost-effective, which makes it ideal for managing human and animal diseases in low-resource environments within One Health framework. A detailed comparative analyses of protocols for genetic engineering , therapeutic payload incorporation on viral backbone, expression in diverse systems such as E. coli, yeast, insect, mammalian cells, or plants with downstream processing shall be presented. Also, some successful case studies using Nano-VLPs will be discussed.

Keywords: Nano Virus Like Particle, Nanoplatform, Nano vaccine, Nano immunology, Pandemic preparedness, Public Health, One Health Approach

Recent Advances In Sustainable Biomaterials and Nanotechnology: Emerging Stragtegies for Therapeutics and Healthcare

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Abstract

Nanomaterials are transforming nanomedicine through the development of new platforms with multiple functionalities for therapeutic delivery, wound management, infection control, diagnostics, and regeneration. Increasing emphasis is now being placed on nanomaterials with bio-functionality, redox regulation, biocompatibility and sustainable synthesis. The cerium oxide nanoparticles are of great interest as therapeutic nanomaterials due to their reversible redox chemistry and their potential to modulate reactive oxygen species (ROS). The research area of our laboratory is multifunctional nanoceria-based biomaterial systems for biomedical applications. The synthesized nanoceria exhibited nanoscale size and a positively charged surface together with a mixed-valence state Ce^{3} /Ce^{4} , which is responsible for its redox activity. The material possessed high antibacterial and antibiofilm efficacy as well as hydrogen-peroxide-scavenging and superoxide-dismutase-like properties, suggesting its broad application in wound-healing and infection control biomaterials of the future. Recent studies are ongoing for the integration of nanoceria with sustainable polymeric and hydrogel matrices to create a bioactive system with multiple actions directed against oxidative stress, microbial infection, and tissue repair. In addition to therapeutic nanomaterials, new developments in nanotechnology are also driving the development of highly sensitive and selective biosensing platforms by combining nanostructured materials with electrochemical, optical, and other transduction technologies. We are continuing our research on this nanomaterial-based method to develop sustainable biosensors, focusing on enhancing sensitivity, selectivity, stability, and the possibility of point-of-care application. In conclusion, our work delves into recent developments in the field of multifunctional nanomaterials and examines the potential for the convergence of redox-active nanoparticles, sustainable biomaterials and nanotechnology-enabled biosensors to develop new nanomedicine platforms. Structural–property relationships, biological mechanisms, sustainability, translational challenges and future opportunities for nanomaterial-based healthcare technologies with clinical relevance will be emphasized in future.

Keywords: Cerium Oxide nanoparticles, Oxidative Stress, Reactive oxygen Species, Biomaterials, Sustainable nanotechnology

A Power-efficient Schmitt-trigger Based 10t Sram Cell For Improved Delay Performance for Wearable Health Devices

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Abstract

A single-ended Schmitt Trigger SRAM (ST10T) cell using 10 transistors is suggested to be used in high-performance memory applications with low power consumption. The design has a decoupled read path to reduce read access time and increase read stability. A further writeability improvement and reduction of the write operation is also achieved by incorporating a storage structure based on a Schmitt Trigger. The proposed SRAM cell is compared with various designs of the SRAM cell such as ST9T, SE10T, ST10T, and P10T cells. The results indicate that the proposed design offers 1.90× more read stability as compared to the SE10T cell, 1.84× more hold stability as compared to the P10T cell, and 2.0× more writeability as compared to the ST9T cell. Also, leakage power and dynamic power are lowered by a factor of 4.93× and 2.17×, respectively. The architecture also reduces read and write delays by 3.19× and 6.07 ×, respectively, compared to the SE10T architecture. The proposed SRAM cell robustness to process variation is further verified by a 1000-run Monte Carlo simulation. In order to get a complete performance assessment, a Figure of Merit (FOM) is composed based on the main design metrics. All simulations are performed in Cadence Virtuoso based on a 45 nm CMOS process and a 1.0 V supply voltage.

Keywords: SRAM, Schmitt-Trigger, Leakage power, Healthcare, wearable devices

Green-synthesized Berberis Aquifolium-functionalized Iron Oxide Nanoparticles for Therapeutic Application In HPV-associated Cervical Cancer

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Abstract

Natural products represent a promising source of anticancer agents; however, their therapeutic application is often limited by poor bioavailability, short half-life, and inefficient cellular delivery. In this study, we developed green-synthesized Berberis aquifolium (BA)-functionalized iron oxide nanoparticles (IONPs) as a nanotherapeutic platform to enhance the anticancer efficacy of plant-derived bioactive compounds against cervical cancer.

Uncoated and BA-functionalized IONPs were synthesized and characterized using UV–Vis spectroscopy, Fourier-transform infrared spectroscopy (FTIR), zeta potential analysis, X-ray diffraction (XRD), thermogravimetric analysis (TGA), scanning electron microscopy (SEM), and transmission electron microscopy (TEM), confirming nanoparticle formation and successful surface functionalization. The anticancer activity of the formulations was evaluated in SiHa, HeLa, and C33A cervical cancer cell lines, followed by validation using a three-dimensional (3D) spheroid model to better recapitulate the tumor microenvironment. Compared with free BA extract and uncoated IONPs, BA-functionalized IONPs demonstrated enhanced cytotoxicity, reduced cellular migration and colony-forming ability, and increased intracellular reactive oxygen species (ROS) generation.

These findings indicate that functionalization of IONPs with B. aquifolium enhances the anticancer activity of the plant-derived bioactive components while providing a nanoparticle-based delivery platform. Overall, BA-functionalized IONPs represent a promising green nanomedicine strategy for cervical cancer and warrant further investigation toward the development of multifunctional nanotherapeutic approaches.

Keywords: Green nanotechnology; Iron oxide nanoparticles; Berberis aquifolium; Cervical cancer; HPV; Nanomedicine; ROS

A Manner for Bacteria Classification based on SERS and Machine Learning Methods

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Abstract

A current challenge in medical diagnostics is the rapid identification of bacterial species and their antibiotic resistance [1,2]. The diagnostic methods developed to date (as of 2026) are not universal; they are time consuming and require complex, expensive equipment. Consequently, the development of fast, simple, and low cost diagnostic approaches remains an important task [3,4].

Surface Enhanced Raman spectroscopy (SERS), a highly sensitive method, can be combined with mathematical data processing methods for rapid analysis of large spectral datasets. It may become a convenient tool for identifying various bacteria, based on the assumption that species specific differences are reflected in their chemical composition. For SERS measurements, previously described SERS active substrates can be used [5,6]. These are fabricated by electron beam evaporation in vacuum and consist of self organized nanostructured silver films on glass or silicon. Their applicability has been confirmed by previous studies, which demonstrated the acquisition of high intensity spectra from various biologically significant analytes, viruses, enzymes, and proteins [6 10].

In this work, we studied three strains of Staphylococcus aureus – two antibiotic sensitive strains with similar resistance spectra and one antibiotic resistant strain – as well as one strain of a different genus, Streptococcus pyogenes. Prior to measurements, bacteria from the culture collection were pre grown for 18 h on agar according to the recommendations for the strains used. After growth, the samples were transferred by a microbiological loop into water and adjusted to an optical density corresponding to a concentration of 108 CFU. The aqueous cell suspensions were subjected to mechanical lysis in a bead mill using ceramic beads for 15 minutes. After centrifugation, the supernatant was collected. Aliquots of the supernatants were sequentially filtered through centrifugal filters (JetSpin, JetBiofil, China) with different molecular weight cut offs (<10, 10 30, 30 50, <50, 50 100, <100, >100 kDa). After filtration, the solutions were deposited onto SERS substrates as three drops of 3 μL per sample and dried under ambient conditions (25 °C). In the dried residue, series of spectra were measured at 60 random points using an excitation wavelength of 532 nm, an accumulation time of 0.5 s per spectrum, and 15 spectra per point.

Epigenetic Reprogramming by Curcumin in Breast Cancer: Reactivation OF GSTP1, HIC1 And CDH1 Tumor-suppressive Pathways

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Abstract

Breast cancer progression is associated with both genetic alterations and reversible epigenetic abnormalities, particularly aberrant DNA methylation-mediated silencing of tumor-suppressor and cancer-protective genes. Curcumin, a major bioactive polyphenol derived from Curcuma longa, has emerged as a potential epigenetic modulator capable of reversing cancer-associated transcriptional repression. This study focuses on the role of curcumin in epigenetic reprogramming of breast cancer cells, with particular emphasis on the reactivation of GSTP1, HIC1, and CDH1 genes. Aberrant promoter methylation of these genes has been associated with their transcriptional silencing and malignant phenotypes in breast cancer. Curcumin may modulate the activity and/or expression of DNA methyltransferases and other chromatin-regulatory mechanisms, thereby promoting demethylation and restoration of tumor-suppressive gene expression. Reactivation of GSTP1 may enhance cellular defense against oxidative and electrophilic stress, while restoration of HIC1 expression may contribute to suppression of inappropriate proliferation and tumor-promoting signaling. Similarly, re-expression of CDH1 (E-cadherin) can strengthen epithelial characteristics and potentially counteract epithelial–mesenchymal transition, invasion, and metastatic behavior. Collectively, modulation of these three genes represents a mechanistically relevant model through which curcumin may influence the epigenetic landscape of breast cancer. Investigating curcumin-mediated changes in promoter methylation, gene expression, and downstream cellular phenotypes could provide important insights into its potential as an epigenetic chemopreventive and therapeutic agent. Such approaches may ultimately contribute to the development of dietary phytochemical-based strategies for molecular prevention and personalized management of breast cancer.

Keywords: Curcumin, Breast cancer, Epigenetic reprogramming, GSTP1, HIC1, CDH1

Bioactive Terminalia Arjuna-loaded Pcl/κ-carrageenan Nanofibers For Controlled Drug Delivery And Wound Healing

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Abstract

Terminalia arjuna (T. arjuna) is a medicinal flora abundant in several phytochemicals and bioactive substances known for their antioxidant, antibacterial, and therapeutic effects. Nonetheless, the efficient administration of herbal bioactive substances to the targeted location while maintaining their stability and biological efficacy continues to pose a significant obstacle. In this investigation, T. arjuna (TA) extract was integrated into polycaprolactone (PCL)/κ-carrageenan (κC) nanofibers via electrospinning to create a prospective nanofibrous drug-delivery mechanism for wound-healing purposes. Electrospun nanofibers present high surface-area-to-volume ratio and facilitate the regulated and prolonged release of bioactive substances. PCL was used to ensure structural stability and mechanical strength, whereas κC was utilized to improve the hydrophilic properties and biocompatibility of the nanofibrous framework.

TA was integrated into the PCL/κC polymeric solution at concentrations of 5%, 10%, and 20%, and then electrospun to produce PCL/κC/TA nanofibers. The structure of the resultant nanofibers was assessed by scanning electron microscopy (SEM). The quantification of TA loading was performed by UV–visible spectroscopy, and the cumulative drug release was analyzed using the Korsmeyer–Peppas (KP) model to ascertain the likely drug-release mechanism. The antioxidant and antimicrobial properties of the nanofibers were assessed, particularly their antibacterial efficacy against Staphylococcus aureus and Escherichia coli. Alterations in bacterial morphology post-treatment were subsequently analyzed utilizing transmission electron microscopy (TEM). The antibacterial effectiveness was examined over a week, and cytocompatibility was measured using an MTT assay on NIH3T3 fibroblast cells. SEM examination disclosed uniform, uninterrupted, beadless, and haphazardly aligned nanofibers. The mean fiber diameter rose from roughly 650 nm to 1.56 µm when TA concentration increased. The loading of TA in the nanofibrous matrix varied between 94 and 163 µg/cm². The drug-release profile conformed to the Korsmeyer–Peppas model, suggesting a mostly diffusion-driven release mechanism. The TA-embedded nanofibers demonstrated over 90% antioxidant efficacy at the concentrations examined. Over 98% antibacterial efficacy was noted against the examined bacterial strains, and TEM examination validated significant morphological damage and rupture of bacterial cells post-treatment. The MTT assay revealed around 116% cell viability, signifying excellent cytocompatibility of the engineered nanofibrous system.

In conclusion, the findings indicate that T. arjuna can be effectively integrated into PCL/κC nanofibers while maintaining its biological activity. The synthesized PCL/κC/TA nanofibers shown advantageous morphological, drug-release, antioxidant, antibacterial, and cytocompatibility properties, emphasizing its promise as a versatile wound-dressing solution. Additional in vivo investigations are necessary to determine their therapeutic effectiveness, ideal dosage, and wound-healing capabilities.

Keywords: T. arjuna, electrospinning, PCL/ kC nanofibers, antimicrobial, controlled drug delivery

Computational Identification of Novel Bruton Tyrosine Kinase (BTK) Inhibitors for Relapsed/Refractory Chronic Lymphocytic Leukemia

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Abstract

Bruton's tyrosine kinase (BTK) is a central mediator of B-cell receptor signaling, activating NF-κB and PI3K pathways that drive survival in B-cell malignancies such as chronic lymphocytic leukemia (CLL). While the FDA-approved BTK inhibitor ibrutinib achieves high response rates, resistance mutations (BTK^C481S, PLCγ2) and off-target effects limit durable efficacy in relapsed/refractory CLL (RR-CLL). We retrieved the BTK crystal structure (PDB ID: 3P08) and screened 98,240 DrugBank compounds using Glide docking (HTVS, SP, XP). Docking scores ranged from −5.524 to −10.372 kcal/mol, and MM/GBSA rescoring identified three promising candidates with superior binding compared to ibrutinib. ADMET profiling, interaction fingerprinting, and Jaguar energy calculations confirmed drug-like properties. Molecular dynamics simulations (100 ns, NPT ensemble) demonstrated stable complexes with RMSD fluctuations < 2 Å and persistent intermolecular interactions.

These findings highlight three computationally identified BTK inhibitors with potential to overcome ibrutinib resistance. Preclinical and clinical validation is warranted to establish their therapeutic relevance in CLL management.

Keywords: BTK, RR-CLL, docking, MD simulation, MM/GBSA

Cytosol-Targeted Dendronized miRNA Nanovesicles Induce Exercise-Mimetic Effects for Obesity Treatment in a Preclinical Mouse Model

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Abstract

Sedentary lifestyle results upregulation of PPARγ expression (key transcriptional factor of adipogenesis) in obesity. Obesity is a chronic illness with multiple contributing factors, brought on by a number of physiological and environmental variables. The primary cause of the condition cannot be treated by current treatment modalities as they treat obesity either by increasing feelings of satiety or by suppressing appetite. Thus, in order to cure obesity, we need a medication that acts at the molecular level. Gene therapy is demonstrating encouraging outcomes in the molecular treatment of a number of disorders. In order to target adipose tissue and reduce off-target effects, this study looks into optimizing targeted nanoformulation of RNAi therapeutic. This miRNA-based formulation will silence the PPARγ to treat the obesity at molecular level. But endosomal trapping and degradation of RNAi therapeutic limits the scope of RNAi therapy. Therefore, in this investigation we have explored the combination of dendrimer-IL as an effective machinery for the cytosolic delivery and endosomal escape. Dendrimer was first complexed with RNAi, which resulted in further loading into aqueous core of nanoformulation. The gel retardation assay was used to optimize the ratio of RNAi complex with the dendrimer. Subsequently, nanoformulation was prepared using thin-film hydration technique, followed by size reduction via extrusion. Higher RNAi entrapment efficiency was achieved by spherical nanoformulation and endosomal escape assay using Flow cytometry revealed better escape. Developed nanoformulation satisfy in vitro safety requirements with hemolysis assay and cytotoxicity assay. The in vivo safety of nanoformulation was further confirmed by hematological and histopathological criteria. The effectiveness of nanoformulation for anti-obesity effects was demonstrated by pharmacodynamic measures, such as decreased body weight, organ weight, better lipid profiling, and changed obesity mRNA and protein markers. Outcome advocates curative fast effective long-term benefits in treating obesity.

Keywords: miRNA, Dendrimer, Nanovesicles, RNAi, Ionizable lipid

Nanomaterial Integrated Conducting Thread Based Electrochemical Biosensor for CYFRA-21-1 Biomarker Detection

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Abstract

Over the last few years, flexible healthcare devices have transformed point-of-care diagnostics. Thread-based sensors offer a practical edge due to their flexibility, breathability, and natural fit for wearable platforms. Bringing this approach to oral cancer screening holds real promise, especially for detecting Oral Squamous Cell Carcinoma (OSCC) early often depends on selection of subtle biomarker like salivary Cytokeratin 19 fragment (CYFRA 21-1). To build a reliable biosensor without expensive or toxic noble metals, we synthesized metal-free graphitic carbon nitride (g-C_3N_4) and confirmed its structural features using X-ray diffraction (XRD), field emission scanning electron microscopy (FE-SEM), attenuated reflectance spectroscopy (ATR) and Raman spectroscopy. We then blended this nanostructured g-C_3N_4 into a conductive poly(3,4-ethylenedioxythiophene): polystyrene sulfonate (PEDOT: PSS) matrix to coat the flexible thread substrate. anti-CYFRA 21-1 monoclonal antibodies has been attached to the functionalized thread, with BSA added right after to block non-specific binding sites. Each assembly stage was checked step-by-step through FE-SEM, ATR, and electrochemical monitoring. The electrochemical response of the fabricated biosensor recorded by chronoamperometry technique and obtained results revealed the excellent sensitivity, high linear detection range and lower limit of detection. The developed biosensing platform proving to be a practical, cost-effective option for early oral cancer screening.

Keywords: Graphitic Carbon Nitride (g-C_3N_4), Flexible Biosensor, CYFRA 21-1, Thread-Based Diagnostics

Poster Presentations

Engineering a Multifunctional Bioinspired Amniotic Membrane-Amyloid Fibril Platform for the Treatment of Infectious Diabetic Foot Ulcers

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Abstract

Diabetic foot ulcers (DFUs) remain among the most challenging chronic wounds, where persistent polymicrobial infection, dysregulated inflammation, oxidative stress, impaired angiogenesis, macrophage dysfunction, and extracellular matrix degradation collectively hinder tissue regeneration and frequently culminate in limb amputation. Despite remarkable advances in wound-care technologies, currently available dressings inadequately address these interconnected pathological processes. Here, we present a bioinspired multifunctional nanobiomaterial that integrates the regenerative extracellular matrix of human amniotic membrane (HAM) with the exceptional nanoscale architecture and mechanical robustness of self-assembled amyloid fibrils to create a next-generation therapeutic platform for precision management of infectious diabetic foot ulcers. The engineered amyloid–amniotic hybrid construct harnesses the intrinsic bioactivity of HAM, providing growth factors, cytokines, collagen, and extracellular matrix proteins that stimulate cellular attachment, proliferation, angiogenesis, and tissue remodeling. The amyloid nanofibrillar network reinforces structural integrity, improves moisture retention, enhances mechanical resilience, and creates a biomimetic microenvironment that supports cell infiltration, nutrient transport, and vascular regeneration. The synergistic integration of these two bioactive components is expected to simultaneously suppress microbial colonization and biofilm formation, attenuate excessive inflammation and oxidative stress, promote macrophage polarization toward a pro-regenerative phenotype, accelerate extracellular matrix remodeling, and facilitate rapid tissue repair. Comprehensive physicochemical characterization, nanoscale structural and morphological analyses, antimicrobial evaluation, cytocompatibility studies, and in vitro regenerative assays will establish the therapeutic potential of the hybrid platform. In addition, antibacterial efficacy, angiogenic activity, macrophage immunomodulation, and wound-healing performance will be systematically investigated to elucidate the underlying mechanisms governing regeneration. By integrating nanostructured amyloid fibrils with clinically relevant amniotic membrane biology, this work introduces a multifunctional regenerative nanomedicine platform that combines infection control with tissue regeneration. This translational strategy has the potential to redefine chronic wound management and establish a new paradigm for precision regenerative nanomedicine for infectious diabetic foot ulcers.

Keywords: Infectious diabetic foot ulcer; Human amniotic membrane; Amyloid fibrils; Hybrid biomaterial; Chronic wound healing; Tissue regeneration; Antimicrobial biomaterials.

Translational Development Of Nanobiocomposite Hemostatic Scaffold As A Point-of-care Medical Device For Rapid Arrest Of Severe Bleeding

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Abstract

Uncontrolled bleeding represents a critical segment of the healthcare and medical device sector, particularly within trauma care, surgical interventions, and emergency medicine. Clinical evidence indicates that nearly 40% of hemorrhage-related deaths occur before hospital admission in both civilian and military settings, underscoring the urgent need for rapid, effective, and safe hemostatic dressings that can be deployed at the point of care. Despite a rapidly growing global and Indian market for woundcare dressings, India continues to rely heavily on imported hemostatic products, leading to high per-unit costs, outflow of foreign exchange and limited accessibility during emergencies, particularly in rural and resource-limited settings. Existing widely used commercial hemostatic dressings (i.e. Gelfoam®, QuikClot®, HemCon®, CeloxTM, AxiostatTM, SurgicelTM, XStat®, EthiziaTM and Fibroplug®) suffer from critical limitations such as insufficient fluid absorption, weak blood-material interaction, slow clotting efficiency, poor mechanical strength, lack of antibacterial activity, toxicity, traumatic detachment, and a high risk of rebleeding. These shortcomings compromise rapid clot stabilization, limit the ability to withstand massive bleeding, disrupt granulation tissue, increase infection risk, delay wound healing and ultimately contribute to higher morbidity and mortality. To address these limitations, we developed a novel nanobiocomposite hemostatic scaffold, comprising bioactive chitosan reinforced multifunctionalized graphene-silver-cationic peptide nanocomposite through patented formulation (Indian Patent No 346127). This integrated technology synergistically promotes rapid hemostasis under severe bleeding conditions while providing potent antimicrobial protection, offering a promising platform for point-of-care device for emergency application. This engineered scaffold was fabricated using a dual-process technology yielding a superporous structure with anisotropically aligned, honeycomb-like micropores that facilitate rapid fluid uptake through capillary-driven transport. The positively charged scaffold surface (= 31.6 ± 0.5 mV) promotes strong electrostatic interaction with blood components, enhancing RBC accumulation, platelet aggregation and activation, which in turn activate the Factor XII-mediated intrinsic coagulation pathway and enhance Factor Xa generation, accelerating fibrin plug for rapid and stable clot formation. Furthermore, preclinical biocompatibility studies conducted under ISO 10993 standards confirmed that the hemostatic scaffold is non-cytotoxic, non-hemolytic, non-irritant, and does not induce any systemic toxicity, supporting its clinical safety. Also, the translational efficacy of hemostatic scaffold was demonstrated through in vivo validation (TRL 5) across multiple clinically relevant bleeding models including rat ear vein, femoral artery and liver laceration models, rabbit femoral artery bleeding, and a large-animal swine femoral artery bleeding model. Across small to large-animal models, scaffold rapidly controlled moderate-to-severe bleeding within 3 minutes, significantly reduced blood loss, and outperformed commercial hemostatic dressings. Interestingly, scaffold also achieved >4-log bacterial reduction (99.99% killing efficiency), providing potent antimicrobial protection at the injury site and addressing the dual challenges of hemorrhage and infection.

Keywords: Nanobiocomposite, Translational nanomedicine, Medical device, Hemostatic scaffold, Rapid bleeding control, Trauma care, and Infection prevention.

Green-Synthesized Nanoparticle-Based Drug Delivery: Convergence with Ayurveda

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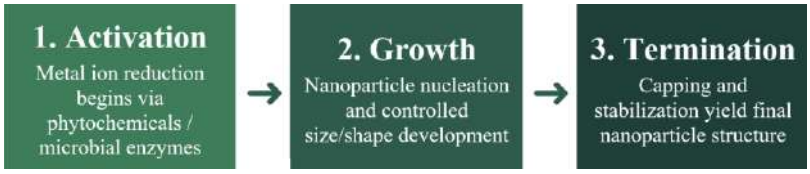
Abstract

Conventional drug delivery faces challenges from antimicrobial resistance, poor solubility of active compounds, and toxic solvents used in nanoparticle fabrication. Green synthesis, using plants, microorganisms, and natural biomolecules, offers an eco-friendly, biocompatible alternative. Meanwhile, Ayurveda's Rasashastra branch has long used incinerated metal and mineral preparations (Bhasmas), representing an early form of nanomedicine. This review explores how green nanoparticle synthesis can be paired with Ayurvedic pharmacology to inform next-generation drug delivery.

Objective: This review aims to (i) summarize recent trends in the biogenic synthesis of metallic, metal-oxide, and polymeric nanoparticles; (ii) evaluate their function as drug carriers; and (iii) explore the potential of integrating green nanotechnology with Ayurvedic principles for infectious and chronic disease management.

Methods: This narrative review draws on published literature covering nanoparticle synthesis, drug-release kinetics, and Bhasma characterization. Green synthesis is examined through its three stages, activation, growth, and termination, while drug-delivery mechanisms are assessed via passive/active loading and targeting, including stimuli-responsive release triggered by pH, heat, magnetism, and ultrasound.

Figure 1. The three characteristic stages of plant-mediated green nanoparticle synthesis: activation, growth, and termination.



Findings: Phytochemicals (tannins, flavonoids, alkaloids, saponins) and microbial enzymes reduce metal ions into nanoparticles with tunable size, shape, and surface chemistry, improving the bioavailability and targeted delivery of poorly soluble compounds. Several Bhasma formulations show compositional parallels with modern metal and metal-oxide nanoparticles, suggesting nanocharacterization could help validate and standardize these traditional preparations.

Conclusion: Green-synthesized nanoparticles offer a sustainable, biocompatible delivery platform, while Ayurveda contributes a centuries-deep repository of natural therapeutics and personalized care. Their convergence is a promising, largely untapped direction for safer, more accessible treatments, provided it is paired with rigorous safety evaluation and clearer regulatory guidance.

Keywords: Biogenic nanoparticles, green synthesis, drug delivery, Bhasma, Ayurveda, nanomedicine

Neuroprotection Against Copper-Mediated Neurotoxicity: Efficacy of chelator Loaded Nanocarriers in Cellular and In-Vivo Model

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Abstract

Excessive copper (Cu^{2+}) accumulation disrupts cellular functions and leads to neurotoxicity via oxidative stress. However, conventional Cu^{2+} chelators face clinical limitations due to poor solubility, instability, short half-life, and adverse effects. To address these challenges, a nanocarrier system encapsulating the chelator was developed, enhancing its stability, solubility, and enabling controlled release. This nanocarrier demonstrated significantly improved cellular uptake in SH-SY5Y and Caco-2 cell lines, while maintaining mitochondrial function and reducing reactive oxygen species (ROS) levels. Pharmacokinetic studies indicated improved absorption, distribution, metabolism, and excretion (ADME) profiles compared to the free chelator. In vivo biodistribution studies further confirmed efficient gastrointestinal uptake and targeted delivery to critical organs. Pharmacodynamic evaluations, including biochemical and histopathological analyses, revealed that the nanocarrier provided superior therapeutic efficacy in reducing copper-induced toxicity. These findings suggest that nanocarrier-based systems can effectively overcome the limitations of traditional chelation therapies, offering an advanced approach for improving therapeutic outcomes in Cu^{2+} overload-related neurodegenerative disorders.

This research underscores the potential of nanotechnology in drug delivery, providing valuable insights for the advancement of chelation therapies. Further exploration into nano-based delivery systems could significantly improve treatment strategies for neurodegenerative diseases linked to metal toxicity.

Impact of molecularly imprinted polymers on graphene oxide-coated screen-printed electrodes for selective immune-sensing of gastric cancer-causing bacteria Helicobacter pylori

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Abstract

Helicobacter pylori (H. pylori) infection continues to be a major public health issue worldwide. The prevalence of H. pylori infection exceeds 50 % worldwide and reaches 70–80 % in developing countries because of inadequate sanitation and restricted healthcare services. The gram-negative bacterium H. pylori hold Group 1 carcinogen status according to the World Health Organization (WHO) because it directly causes chronic gastritis, mucosa-associated lymphoid tissue (MALT), peptic ulcer disease, and gastric adenocarcinoma. This calls for an immediate need for better diagnostic approaches. The gastric mucosa colonization of the bacterium depends on outer membrane proteins, including BabA, OipA, and SabA, which facilitate both adhesion and pathogenicity. The current diagnostic approaches, including biopsy, histology, endoscopy, fecal antigen tests, ELISA, serology, western blotting, urea breath tests, and PCR, face challenges related to complexity, high costs, and low sensitivity. The development of electrochemical biosensors represents a promising diagnostic solution because they provide fast results at affordable prices and portable devices for on-site testing. The incorporation of molecularly imprinted polymers (MIPs) as synthetic receptors with predefined recognition sites for target analytes improves both selectivity and stability of these biosensing platforms. The research introduces an innovative electrochemical biosensor system that detects BabA antibodies (BabA-Ab), which serve as important immunological indicators of H. pylori infection. The sensor platform consists of graphene oxide (GO) that integrates with a BabA-Ab-imprinted polymer matrix. A non-imprinted polymer (NIP) sensor device was constructed simultaneously with the BabA-Ab-imprinted polymer sensor to function as a control reference. The research demonstrates how GO/MIP-based electrochemical sensors can function as advanced clinical diagnostic instruments for fast and precise medical testing.

Development Of A Dual-responsive Biogenic Silica Nanocarrier From Agricultural Biomass Exhibiting And-gate-like Release Behaviour

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Abstract

Agricultural biomass residues represent an abundant yet underutilized resource that can be transformed into value-added materials through sustainable processing approaches. The present study investigated the extraction, characterization, and application of biogenic silica derived from Saccharum officinarum leaves and Zea mays cob husks as renewable biomass sources. The study was motivated by the growing need for environmentally sustainable nanomaterials and the increasing emphasis on biomass valorization within the framework of green nanotechnology and circular bioeconomy principles.

Biogenic silica was extracted from both biomass sources using an alkaline extraction–acid precipitation method followed by calcination and purification. The recovered materials were characterized using X-ray fluorescence (XRF), Fourier-transform infrared spectroscopy (FTIR), X-ray diffraction (XRD), dynamic light scattering (DLS), zeta potential analysis, thermogravimetric analysis (TGA), CHN analysis, and nuclear magnetic resonance (NMR) spectroscopy to evaluate their elemental composition, structural characteristics, thermal stability, particle size distribution, and surface properties. The characterization studies confirmed the successful recovery of silica-rich materials exhibiting characteristic silica-associated functional groups, predominantly amorphous structural features, and negatively charged particle surfaces indicative of moderate colloidal stability. Comparative evaluation revealed that Saccharum officinarum yielded slightly higher silica recovery and exhibited comparatively favorable colloidal characteristics than Zea mays under the extraction conditions employed in this study. To explore the functional application of the extracted materials, a dual-responsive silica-based release system was developed using methylene blue as a model cargo molecule. A biodegradable starch–gelatin coating was employed as a biomolecular cap, while trisodium citrate was incorporated as a stabilizing component. The release behavior of the system was evaluated under varying pH and enzymatic conditions to investigate its responsiveness toward multiple environmental stimuli. The results demonstrated enhanced cargo release under acidic and enzyme-rich environments, indicating the dual-responsive nature of the developed system. Gelatin swelling studies further revealed greater swelling under acidic conditions, supporting the proposed mechanism of pH-induced matrix expansion and increased cargo diffusion. The highest release response was observed when acidic pH and α-amylase were simultaneously present, suggesting a release profile analogous to an AND-gate operation. Although measurable release occurred under all experimental conditions and the system did not fully satisfy the criteria of a true molecular AND gate, the results demonstrated a clear AND-gate-like release behaviour driven by the combined effects of gelatin swelling and starch degradation. These findings provide preliminary proof-of-concept evidence for the development of dual-responsive release systems based on biomass-derived silica.

Highly Stable Copper Nanoparticle-functionalized Carbon Nanotube Nanocomposite Based Sensor for Rapid On-site Nitrate Detection in Soil And Water Samples

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Abstract

Nitrate (NO_3^-) ion contamination of water is a major issue that affects many parts of the world due to excessive usage of nitrogen containing fertilizers in soil. Hence quantification of NO_3^- ion in soil and water is of utmost importance. In this present research work, we have developed an efficient and highly stable non-enzymatic electrochemical sensor for NO_3^- ion detection based on allylamine capped copper nanoparticles (Alym@CuNPs) decorated on multi-walled carbon nanotubes (fCNT). Herein, we have addressed the sensor surface storage stability issue of copper nanoparticles (CuNPs) based electrochemical sensors for the first time and confirmed superior storage stability of Alym@CuNPs modified glassy carbon electrode (GCE) over uncapped copper nanoparticles (uCuNPs) and electrodeposited copper nanoparticles (eCuNPs) modified GCE. The synthesized Alym@CuNPs material also shows very high storage stability up to 7 months which is confirmed by physical characterization (XRD) that suggests the incorporation of allylamine hinders environmental oxygen to react with CuNPs and prevents its oxidation. The prepared optimised, CuNPs-fCNT nanocomposite was further translated to gold sputtered miniaturised electrode (AuSE) for onsite testing application. The modified AuSE significantly increases the electrochemical performance due to high conductivity and large surface area, resulting in a detection time of under 5 minutes with reusability for up to 6 analyses. The proposed sensor demonstrates excellent long-term stability up to 75 days with 95.0% current retention and cost-efficiency (~$0.15 per strip). It offers broad linear detection ranges from 10–800 µM in soil, R^2 = 0.998 and 10–1000 µM in water, R^2 = 0.999 with low limits of detection of 4.69 µM in soil and 4.96 µM in water. Sensor validation with on-site samples across agricultural fields, run off and water bodies revealed high accuracy, with recovery rates of 100 ± 10% and no statistically significant difference (P > 0.05) between spiked and detected concentrations. This developed NO_3^- sensing platform provides a scalable, user-friendly, and on-site solution for precision agriculture and environmental monitoring.

Keywords: Electrochemical nitrate sensor, non-enzymatic sensing, CuNPs-fCNT nanocomposite, storage stability, on-site detection, soil and water analysis

Fabrication and Physicochemical Characterization of a Metal-Organic Framework-Based Drug Delivery System for Ciprofloxacin

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Abstract

Rising antibiotic resistance is a serious concern for living beings and human health; combined with the poor bioavailability and rapid clearance of many conventional antibiotics, it has increased the market for smarter ways to deliver these drugs. Metal-Organic Frameworks (MOFs) are crystalline, highly porous materials composed of metal ions linked by organic molecules, which have drawn attention for their precisely tunable pore sizes and surface chemistries, making them well-suited to carry and release drugs in a controlled manner. This study fabricates a cobalt-based MOF using a solvothermal approach and loads it with the ciprofloxacin drug, a widely used fluoroquinolone antibiotic, via post-synthetic impregnation.

The resulting material was examined with several characterization techniques like Powder X-Ray diffraction, FT-IR, Raman, FE-SEM, HR-TEM, EDAX, SAED, BET, and TGA to understand both its structure and drug delivery capabilities. The Powder X-Ray diffraction confirms the material has excellent crystallinity, while FT-IR confirms the bond formation between the cobalt and the nicotinic acid, where nicotinic acid acts as the monodentate ligand. FE-SEM imaging gave us a picture of particle morphology, and EDAX confirmed the elemental composition of the framework size with HR-TEM was used to provide finer structural details, including the lattice fringes and particle-level crystallinity that FE-SEM alone couldn't resolve, and the SAED pattern further confirmed the crystalline nature of the framework, with the diffraction spot indexed to a consistent lattice plane. TGA helped establish how thermally stable the material is and roughly how much organic content it contains. BET analysis showed the surface area and pore volume of the framework's internal space.

The drug delivery capabilities of the Co-NA mof were tested using the disc diffusion method against E.Coli. bacteria. The eye drop of ciprofloxacin was used for the drug loading purposes via post-synthetic impregnation; The drug loaded mof gives the zone of inhibition after 5 minutes, which shows the successful release of the drug from the pore of the MOF. Initially, the zone of inhibition was larger, which is due to the burst release of the drug; then we observe with time, the zone of inhibition increased in its radius, which showed the controlled release of the drug till the 30 minutes. Further, we are planning to control the release of the drug in an adequate dose and check the effect of pH on the drug-releasing capability of the metal-organic framework.

Keywords: Metal-Organic Frameworks, ciprofloxacin, antibiotic, drug delivery, fabrication, characterisation, controlled release

Computational- Guided Identification Of Antimicrobial Candidates And Liposomal Nanocarrier Development Against Priority Drug- Resistant Pathogens

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Abstract

Antimicrobial resistance (AMR) poses a critical challenge in the treatment of infections caused by priority drug-resistant pathogens, necessitating the development of alternative antimicrobial candidates and effective delivery strategies. In this study, an integrated computational and experimental approach was employed to identify a phytochemical antimicrobial candidate and develop a liposomal nanocarrier platform for its potential delivery against drug- resistant bacterial pathogens. A library of approximately 50 FDA- approved drugs and bioactive phytochemicals was subjected to ADMET profiling and molecular docking against selected therapeutic targets of Staphylococcus aureus and Acinetobacter baumannii. Based on comparative computational screening, Hesperidin was prioritized for further investigation and its protein- ligand complexes were evaluated using 100 ns molecular dynamics simulations through RMSD, RMSF, radius of gyration, Dynamic cross- correlation and free- energy landscape analyses. Hesperidin exhibited favourable predicted binding toward S. aureus dihydrofolate reductase and A. baumannii glutamine synthetase, with docking scores of −10.7 and −11.1 kcal/mol, respectively, and demonstrated stable dynamic behaviour during simulation. Experimental antibacterial evaluation confirmed measurable activity of hesperidin against MRSA, with a zone of inhibition of 20 ± 1 mm and MIC of 128 µg/mL, while the established antibacterial drug ciprofloxacin, used as a reference control, exhibited 25 ± 2 mm and 0.96 µg/mL, respectively. Against A. baumannii, hesperidin showed a zone of inhibition of 15 ± 1 mm and MIC of 1024 µg/mL, compared with 20 ± 1 mm and 3.84 µg/mL for ciprofloxacin. To advance the selected phytochemical toward a nanomedicine- based delivery strategy, hesperidin- loaded liposomes comprising egg phosphatidylcholine, cholesterol and oleic acid were developed using thin- film hydration method. The integrated findings demonstrate a computationally guided approach for prioritizing phytochemical antimicrobial candidates and establishing their translation into liposomal nanocarriers, providing a foundation for further optimization of hesperidin- based nanomedicine strategies against drug-resistant bacterial infections.

Keywords: Antimicrobial resistance; Hesperidin; Molecular docking; Molecular dynamics; Liposomes; Nanocarrier; Drug delivery

A Prospective Nanotherapeutic Platform For Preserving The Osteo-vascular Integrity Under Simulated Microgravity

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Abstract

Prolonged spaceflight exposes astronauts to cosmic radiation and microgravity, taking a severe toll on their overall health. This triggers a cascade of physiological degradation, which is fundamentally driven by unmitigated oxidative stress and mechanical unloading. Among the most notable are rapid bone loss and cardiovascular deconditioning, which lead to fluid shifts and compromise overall function. In space medicine, spaceflight-induced osteopenia and vascular deconditioning have usually been investigated as isolated physiological phenomena. However, bone regeneration and vascularization are components of a tightly coupled physiological microenvironment in which specialized capillary networks deliver essential signals for osteogenesis, and osteoblasts reciprocally regulate local angiogenesis .

Under microgravity, mechanical unloading and fluid redistribution throughout the body trigger a massive intracellular surge of reactive oxygen species (ROS) that disrupts this cross-talk. This oxidative stress acts as a double hit: in osteoblasts, it dismantles the actin cytoskeleton, shutting down the mechanical signaling pathways necessary for bone matrix formation. Simultaneously, ROS pushes supporting endothelial cells into apoptosis and paradoxically triggers chaotic, pathological angiogenesis. Instead of supporting bone growth, these structurally immature, leaky vessels sever the critical biochemical cross-talk required to sustain osteoprogenitors and can even recruit bone-resorbing osteoclast cells. While neutralizing ROS is a well-practiced therapeutic strategy, conventional small-molecule antioxidants suffer from rapid systemic clearance, poor intracellular retention, and low bioavailability, limiting their clinical utility. To solve this delivery bottleneck, we engineered a zein-based nanotherapeutic system. By encapsulating a chimeric antioxidant cocktail within these ~200 nm protein nanocages, we aimed to bypass traditional drug clearance pathways and achieve sustained, intracellular ROS neutralization. We hypothesized that because oxidative stress is a major driver of physiological disruption, a single targeted nanomedicine platform could protect both osteoblastic architecture and endothelial viability, preserving the entire bone-endothelial axis under microgravity conditions

Conclusion: This study demonstrates that the bone-endothelial axis can be protected from microgravity-induced uncoupling through a targeted nanomedicine strategy. By using zein nanocages to deliver a repertoire of antioxidant payloads to overcome the bioavailability limitations of traditional antioxidants, we achieved dual protection: preserving the structural and mechanotransductive integrity of osteoblasts while simultaneously stabilizing the supporting endothelial network. This single-platform nanotherapeutic offers a comprehensive, highly translational countermeasure for managing spaceflight-induced physiological deconditioning, with significant potential for treating terrestrial osteoporosis and other age-related osteo-vascular diseases.

Keywords: Protein nanoparticles, bone-endothelial axis, simulated microgravity, nanotherapeutics, osteogenesis, endothelial dysfunction, oxidative stress.

Fabrication of an electrochemical sensor based on molecularly imprinted polymer for the detection of astaxanthin

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Abstract

Astaxanthin (ASTX) is a xanthophyll pigment that exhibits strong antioxidant properties, enabling plants to resist stress, promote soil fertility, and enhance environmental health. The detection of ASTX using sensors is vital due to its extensive biological, ecological, and industrial benefits. Currently available techniques, including HPLC-DAD and LC-MS, are efficient but costly, labour-intensive, and require skilled personnel. To address these limitations, we developed a novel electrochemical platform based on a screen-printed electrode (SPE) modified with a metal-organic framework (MOF) and a molecularly imprinted polymer (MIP). SPE facilitates the development of a compact, portable, and user-friendly sensing platform. In addition, the electrodeposition of MOF-UiO-66 (Zr) enhances electrical conductivity, while MIP ensures improved selectivity and sensitivity. The developed platform enables quicker and cheaper detection of ASTX within seconds. The sensor was further optimized for pH, temperature, concentration, reproducibility, and sensitivity assessment. The present study demonstrated a lower limit of detection of 0.2 nM, with a sensitivity of 0.579 mA/nM, and a broad linear range (0.2 nM to 500 nM), respectively.

Keywords: Astaxanthin, Electrochemical Sensing, Screen-Printed Electrode, Molecularly Imprinted Polymer, Metal-Organic Framework

Inorganic Metal Nano-antibiotics For Antimicrobial Resistant Microbes

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Abstract

Antimicrobial resistance (AMR) is a major threat to human health and increases the cost of healthcare, especially in terms of chronic disease, hospitalization, and mortality. World Health Organization (WHO) has identified the pathogens of ESKAPE as a major threat due to their high level of resistance and associated mortality. Nano-antibiotics based on inorganic metal oxide can be used to treat current cases of AMR by following a complex multi-mode killing mechanism, including membrane disruption, reactive oxygen species (ROS) and genetic material binding, which can also inhibit resistance development. In this work, a Composite Metal Oxide (CMO) based Nano-antibiotic of size 15-25 nm was synthesized using reduction process at RT without any stabilizer and structure was confirmed by standard physicochemical characterization techniques. To assess the antimicrobial properties of the CMO bacteria killing mechanism, zone of inhibition and Minimum Inhibition Concentration on standard and clinical bacterial and fungal strains are conducted in in-vitro. In addition, CMO were tested in in-ovo and in-vivo infection models to establish their translational potential. The results of these experiments show that the minimum inhibitory concentration for different bacterial and fungal stains is between 0.5 and 62.5 µg/ml, and the zone of inhibition for the nano-antibiotics is between 8.0 and 16.3 mm. The in vivo infected wound model demonstrated their potential to close the wounds within 10 days of post-treatment without any inflammation. Together, these findings with in ovo study offer an improved safety profile of CMO antibiotics for future clinical trials.

Keywords: Inorganic Nano-antibiotics, Antimicrobial Resistance, Infected Wound healing, complex multimode killing mechanism.

Alpha-tocopherol-conjugated DNA Tetrahedron with Enhanced Cellular Uptake and Cytotoxicity for Cancer Therapeutic

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Abstract

Cancer remains one of the most fatal diseases worldwide. Current therapies often lack specificity and cause toxicity to healthy tissues. DNA nanotechnology, an emerging interdisciplinary field, facilitates the design of programmable, biocompatible, and structurally precise DNA-based nanostructures, with promising applications in drug delivery, biosensing, and therapeutics. However, the negatively charged plasma membrane limits the cellular uptake of negatively charged DNA nanostructures. Although strategies such as cationic lipid coating or electrostatic complexation have been explored to enhance DNA stability, these approaches can exhibit heterogeneous lipid coverage and batch-to-batch variability, potentially leading to variable protective efficacy. Furthermore, drug delivery using DNA tetrahedron (TD) or conventional chemotherapies frequently results in off-target effects due to poor drug specificity. To address these challenges, this study explores the conjugation of a hydrophobic molecule, alpha-tocopherol succinate (αT), known for its selective cytotoxicity toward malignant cells over normal cells at appropriate concentrations. In this study, we engineered a hydrophobic TD by conjugating αT (TD_αT) to an amino-modified M1 oligonucleotide using HOBt–EDC amide coupling. This was followed by one-pot self-assembly with complementary strands to form the TD_αT conjugate. The TD_αT conjugate maintained the selective toxicity of αT, and cellular uptake varied between different cancerous and non-cancerous cell lines. TD_αT induced elevated reactive oxygen species (ROS) generation, leading to apoptosis specifically in malignant cells. These findings demonstrate a DNA nanostructure-based delivery platform that combines selective cytotoxicity with improved cellular internalization, offering a promising strategy for targeted cancer therapy.

Keywords: DNA Tetrahedron, Alpha-tocopherol succinate, Selective cytotoxicity, Covalent Conjugation, Cancer therapeutics

Quality-by-design Optimized Albumin Nanoparticles Encapsulating Artemisia Annua L. Phytochemicals Using Artemisinin As A Quantitative Marker

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Abstract

Herbal therapeutics continue to represent a valuable source for drug discovery and development; however, their clinical translation is often limited by poor aqueous solubility, low bioavailability, rapid systemic elimination, and batch-to-batch variability. Artemisia annua L. is a representative example, as the therapeutic potential of its major bioactive constituent, artemisinin (ART), and associated phytochemicals is constrained by physicochemical instability and unfavorable pharmacokinetic properties. In this study, a robust nano-delivery system for A. annua whole-leaf extract (AAWLE) was developed using a Quality-by-Design (QbD)-based strategy. Human serum albumin nanoparticles (HSA-NPs) were formulated following quantitative estimation of ART in AAWLE, which served as a marker compound to ensure reproducibility and consistency across batches. A fractional factorial design (fFD) was employed to identify and evaluate critical material attributes (CMAs) and critical process parameters (CPPs) influencing critical quality attributes (CQAs), including particle size (PS), polydispersity index (PDI), zeta potential, and encapsulation efficiency (EE). Subsequently, optimization through a Box-Behnken design (BBD) established a statistically validated design space. The optimized AAWLE-HSA-NPs exhibited particle size below 100 nm, PDI of 0.23, zeta potential of -22.11 mV, high drug-loading efficiency, and approximately 95% particle yield. The formulation demonstrated biphasic drug release with an initial burst followed by sustained release and showed favorable gastrointestinal stability with minimal changes in PS and EE above 93%. These findings demonstrate the successful integration of QbD principles and nanotechnology to produce reproducible AAWLE-HSA-NPs with desirable physicochemical characteristics, acceptable stability, and sustained in vitro drug release behavior.

Keywords: Artemisia annua L., Human serum albumin, Nanoparticles, Quality-by-design, Artemisinin, Polymeric nanoparticles and controlled drug release.

Fabrication Of Bioactive Cellulose-pectin Films For Wound Healing Application

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Abstract

Vitamin C (Ascorbic acid) is an excellent biomolecule with antioxidant properties and also supports immune function. Thus, using it as a biotemplate for the synthesis of bioactive glass (BG) via a green, bio-inspired route increased the bioactivity of the synthesized BG. Ascorbic acid consists of multiple OH groups which formed H-bonding with silanol species and influence the BG network. BG is one of the best biomaterials used for both hard and soft tissue regeneration. It releases therapeutic ions and forms a hydroxy carbonate apatite layer when exposed to physiological fluids.

Pectin is a polysaccharide with antioxidant activity and good gelling ability, making it a suitable candidate for film formation. It also facilitates cell adhesion. Although it has some mechanical constraints which were overcome by the addition of methyl cellulose. Methyl cellulose is another polysaccharide used in the film which provided structural integrity and optical clarity. It also reduced brittleness of the film for better handling. Wound healing films should be generally a little flexible which was achieved by using glycerol as a plasticizer. BG incorporated cellulose-pectin films possessed greater tensile strength as compared to those without them as BG also enhanced the mechanical properties. FTIR results confirmed the BG network formation. The fabricated films are expected to be biocompatible with good wound healing potential.

Keywords: Bioactive glass, wound healing, bio-inspired, methyl cellulose, pectin

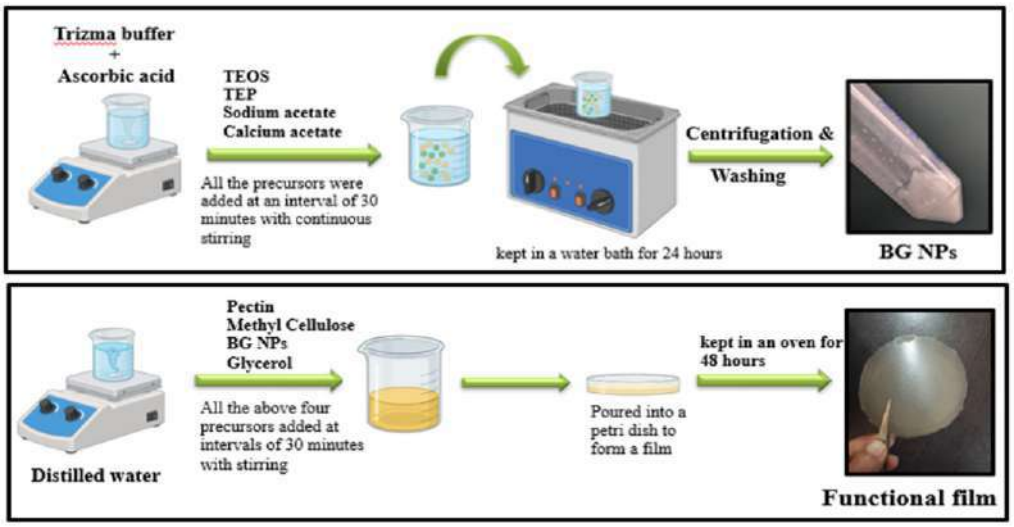


Figure 1: Synthesis of BG and fabrication of bioactive films

Nanostructured Impression Cytology for Rapid Molecular Screening of Ocular Surface Squamous Neoplasia

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Abstract

Ocular surface squamous neoplasia (OSSN) represents a spectrum of dysplastic and malignant epithelial lesions of the conjunctiva and cornea, ranging from intraepithelial neoplasia to invasive squamous cell carcinoma. Early diagnosis enables timely treatment, improving clinical outcomes. Among the currently available minimally invasive approaches, the cellulose acetate membrane (CA)-based impression cytology technique has reached widespread use for collecting and analyzing superficial ocular surface epithelial cells. This involves gently placing a CA membrane onto the ocular surface so that epithelial cells adhere to the membrane for subsequent cytological examination. Compared to conventional tissue biopsy, the technique is relatively simple, noninvasive and repeatable, making it particularly advantageous when assessing ocular surface lesions. In the proposed platform, this conventional CA membrane would be further modified with a micro/nanotextured surface architecture designed to enhance cell–surface interactions and cellular adhesion, enabling efficient epithelial cell capture at reduced applied pressure. The limitation of standard impression cytology lies in its demand for representative cells to be collected, stained and examined under the microscope for cytological interpretation. This can be time-consuming, and the lack of immediate molecular diagnostic output is an additional disadvantage. Conventional morphological assessment also requires the interpretation of experts and might suffer from limitations in distinguishing early neoplastic changes from other ocular surface abnormalities. Hence, there is a strong need to retain the noninvasive advantages of CA membrane-based sampling but for faster and more sensitive biomarker-based analyses. In this respect, we have proposed an integrated diagnostic platform using the CA membrane-based impression cytology with a nanomaterial-enabled biosensor chip for early OSSN screening and high-risk HPV detection. After non-invasive ocular surface cell collection with the CA membrane, disease-associated biomarkers would be detected using antibody-coated gold nanoparticles (AuNPs) functionalized with target-specific antibodies or nucleic acid probes. The biosensor has two targets: Ki-67, an established cellular proliferation marker in OSSN and high-risk HPV E6/E7 nucleic acids representing oncogenic HPV infection. Functionalized AuNPs with specific antibodies or nucleic acid probes constitute the nanoscale signal-generating entity. Recognition of the target leads to the local accumulation of AuNPs at specific test lines, thus rendering a visible colorimetric signal through their typical optical properties. The control line confirms the validity of the assay. The proposed system is an extension, not a substitute, for the well-established technique of impression cytology. By combining traditional noninvasive cellular sampling with nanoparticle-based biomarker sensing, the platform minimizes the lag time between sample collection and diagnostic output. It enhances the possibility of early molecular screening of OSSN. After further optimization and clinical validation, such a platform could provide rapid, minimally invasive and possibly portable adjuncts to early detection and screening of ocular surface neoplasia.

Keywords: OSSN, Impression Cytology, Nanodiagnostics, Cellulose Acetate, Biomarkers

Advancing Topical Minoxidil Delivery For Androgenetic Alopecia: From Conventional Formulations To Nanoemulgel Based Delivery

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Abstract

Introduction: Androgenetic alopecia (AGA) is one of the most prevalent types of progressive hair loss and can greatly impact the psychological and social well-being of those affected. Minoxidil remains one of the most commonly used topical medications for AGA. However, traditional minoxidil formulations, especially hydroalcoholic solutions, come with drawbacks such as poor drug retention on the scalp, irritation related to the formulation, limited control over drug release, and inconsistent patient compliance. These drawbacks have prompted the creation of advanced topical delivery systems that aim to enhance the local delivery and efficacy of minoxidil.

Objective: This review seeks to critically assess the development of topical minoxidil formulations, focusing specifically on the shift from traditional formulations to those utilizing nanoemulsion and nanoemulgel delivery systems. Additionally, the review examines the formulation factors that affect the efficacy of these advanced systems and highlights existing challenges as well as potential avenues for future research.

Discussion: Conventional topical formulations of minoxidil, which include solutions, foams, and gels, ease administration but encounter difficulties related to drug solubility, residence time, release characteristics, and scalp tolerability. Nanoemulsions present a viable option for topical delivery, as their nanoscale droplets improve drug solubilization and interaction with the skin. Nevertheless, liquid nanoemulsions may face challenges regarding residence time and application properties on the scalp. By incorporating an optimized nanoemulsion into a gel matrix, a nanoemulgel system can be created that enhances viscosity, spreadability, and residence time while preserving nanoscale attributes. The effectiveness of minoxidil nanoemulsion/nanoemulgel systems is affected by formulation parameters such as oil phase selection, surfactant concentrations, droplet size, viscosity, pH, and polymer concentration. Therefore, comprehensive characterization of drug release, skin permeation, stability, and scalp compatibility is crucial for evaluating therapeutic potential. Despite encouraging preclinical findings, obstacles such as formulation stability, surfactant irritation, scalability, and restricted clinical application persist.

Conclusion: The shift from conventional minoxidil formulations to nanoemulsion and nanoemulgel systems represents a promising strategy to improve topical drug delivery in androgenetic alopecia (AGA).

Keywords: Minoxidil; Androgenetic alopecia; Nanoemulsion; Nanoemulgel; Topical drug delivery; Hair loss.

Understanding the Influence of Molarity, Buffer Capacity, and pH on Product specific Guidance Dissolution Method for Developing a Discriminatory Dissolution Method for the Development of Mesalamine Products

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Abstract

Oral drug delivery remains the most ubiquitous and patient-preferred route of administration, yet it poses substantial biopharmaceutical hurdles for localised gastrointestinal therapies. Mesalamine (5-aminosalicylic acid, MES) is a cornerstone anti-inflammatory agent indicated for the induction and maintenance of remission in ulcerative colitis and Crohn's disease (CD). To achieve maximum therapeutic efficacy, MES must reach colonic lesion sites at high intraluminal concentrations while minimising systemic absorption. However, successful targeted delivery is governed by a highly complex and variable GI environment, characterised by fluctuating pH gradients, shifting fluid volumes, distinct viscosity profiles, variable transit times, and localised buffer capacities (β). Consequently, modified-release MES dosage forms are classified as consistently highly variable drug products. The intra-subject variability (ISV) for commercially available formulations is exceptionally high. For instance, Lialda® exhibits an ISV exceeding 75% for Cmax and 50% for AUC. Similarly, Pentasa® demonstrates variability, with ISV values surpassing 50% for Cmax and AUC. Demonstrating bioequivalence for these locally acting products is a rigorous process, demanding extensive in vitro dissolution profiles across multiple pH media alongside partial or full replicate pharmacokinetic studies with a greater number of subjects.

The lack of formulation robustness and unpredictable in vivo drug release can culminate in severe clinical pathologies. In patients with Crohn's disease who exhibit intestinal strictures, unreleased or partially dissolved tablets can accumulate, forming dangerous pharmacobezoars (bowel obstructions composed of undissolved pills). Multiple clinical cases emphasise this risk. The experimental data revealed distinct, mechanism-dependent dissolution trajectories between the PRG and MMX® technologies. PRGs exhibited a markedly slower drug release profile when exposed to low-molarity media. Interestingly, changes in buffer capacity (β) yielded no observable effect on drug release when PRGs were evaluated in acetate media at pH 4.3. At this specific pH, MES remains a poorly soluble zwitterion, meaning its dissolution is strictly solubility-limited rather than buffer-dependent. In contrast, MMX® tablets proved to be very sensitive to buffer molarity and capacity. When tested in the physiologically relevant 25 mM phosphate buffer, the MMX® matrix exhibited significantly delayed and slower release profiles. This low-molarity environment effectively unmasked critical formulation differences between generic versions and the reference innovator product. This disparity clearly demonstrates the superior discriminatory power of low-molarity media; high-strength compendial buffers create an artificial, highly buffered environment that suppresses and masks underlying formulation and manufacturing discrepancies.

This investigation demonstrates that buffer molarity, capacity (β), and media pH are critical parameters that dictate the dissolution kinetics of modified-release MES formulations. High-molarity compendial media (160 mM) tend to artificially accelerate pH-dependent dissolution, misrepresenting the true in vivo environment and hiding differences that lead to bioequivalence failures. Implementing biorelevant, low-molarity (25 mM) dissolution methods provides a highly discriminatory tool. Integrating these low-β methodologies into generic drug development frameworks is an essential strategy to refine batch homogeneity, prevent unexpected bioequivalence failures, and minimise pill burdens.

Keywords: Biorelevant release, Prolonged release granules, Buffer capacity, Mesalamine, Inflammatory bowel disease

N-Aryl Arylidene Succinimides as Potential Anti-TNBC Agents: Synthesis, Biological Evaluation and Structure-Activity Relationship Studies

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Abstract

Triple-negative breast cancer (TNBC) is an aggressive breast cancer subtype with limited targeted therapeutic options, highlighting the need for new anticancer scaffolds. In this study, a library of N-aryl arylidene succinimide derivatives were designed and synthesized to investigate the influence of N-aryl and arylidene substitution on biological activity. The compounds were prepared through a triphenylphosphine-mediated Wittig-type condensation of N-substituted maleimides with structurally diverse aromatic aldehydes, affording a range of electron-rich, electron-deficient, heteroaromatic, and fused-aromatic derivatives. A series of bis-succinimide analogues was also synthesized to examine the effect of increased molecular architecture. The synthesized compounds were characterized by ^{1}H NMR, ^{13}C NMR, and HRMS.

The compounds were evaluated for their antiproliferative activity against a panel of human cancer cell lines, with several derivatives showing pronounced activity against MDA-MB-231 TNBC cells. The most active derivatives demonstrated strong growth inhibition, with the lead analogue exhibiting 95.9% inhibition at 10 μM and an IC_{50} of 0.43 ± 0.06 μM. SAR analysis indicated that hydrophobic N-aryl substitution combined with electron-withdrawing arylidene groups, particularly CF_3-containing substituents, favoured antiproliferative activity, while expanded aromatic systems also showed promising activity in selected cases. Overall, these findings establish N-aryl arylidene succinimides as promising anticancer scaffolds and provide preliminary SAR insights for further structural optimization. Future studies will focus on mechanistic investigations, molecular docking, and target-validation studies to elucidate the molecular basis of their antiproliferative activity and assess their potential as therapeutic leads against TNBC.

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$CuFe_2O_4$@AGAR@Cu_2O Nanocatalyst: A Sustainable Approach to The Synthesis OF 1,4-benzodiazepines and 1-ARYL-1H-tetrazoles

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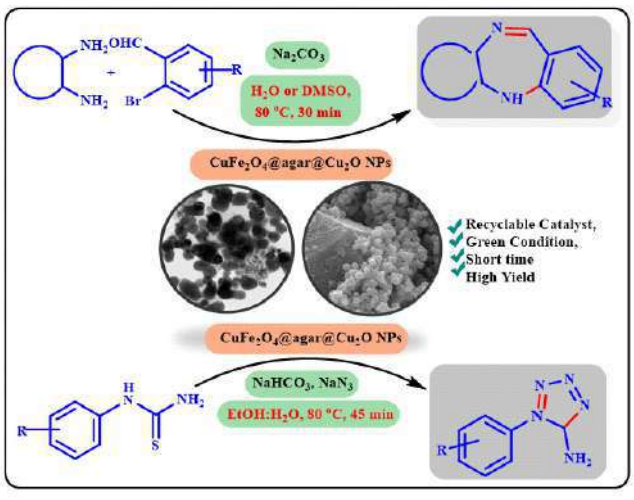
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Abstract

The development of efficient, recyclable, and environmentally benign heterogeneous nanocatalysts has gained considerable attention for the sustainable synthesis of biologically important N-heterocyclic compounds. In this study, a novel agar-stabilized magnetic nanocatalyst, $CuFe_2O_4$@Agar@Cu_2O, was developed for the efficient synthesis of 1,4-benzodiazepines and 1-aryl-1H-tetrazoles. The $CuFe_2O_4$ magnetic core was surface-functionalized with agar to facilitate the effective immobilization and stabilization of Cu2O nanoparticles. The synthesized nanocatalyst was comprehensively characterized using PXRD, FTIR, XPS, FESEM, TEM, EDAX, TGA, and BET analyses.

The catalytic efficiency of $CuFe_2O_4$@Agar@Cu_2O was evaluated for the synthesis of 1,4-benzodiazepines from 2-halobenzaldehyde and 1,2-diamines, as well as 1-aryl-1H-tetrazoles from phenylthiourea and sodium azide under mild and sustainable reaction conditions. Both transformations afforded the desired products in high yields with a broad substrate scope, short reaction times, and simple product isolation. Importantly, the magnetic nature of the catalyst enabled facile recovery and reuse for up to five consecutive cycles with minimal loss of catalytic activity.

The developed methodology demonstrated excellent green chemistry performance, with Process Mass Intensities (PMI) of 1.55 and 1.44, E-factors of 0.55 and 0.44, Reaction Mass Efficiencies (RME) of 66.52% and 74.2%, and Carbon Efficiencies of 97% and 93% for benzodiazepine and tetrazole synthesis, respectively. Overall, the $CuFe_2O_4$@Agar@Cu_2O nanocatalyst provides a robust, recyclable, and sustainable platform for the synthesis of pharmaceutically relevant N-heterocyclic scaffolds, highlighting its potential for greener chemical synthesis.



Keywords: $CuFe_2O_4$@agar@Cu_2O Nanoparticles, 1,4-Benzodiazepines, 1-Aryl-1H-Tetrazoles, green chemistry matrices, heterogeneous catalysis.

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Mitigating metal oxide NPs toxicity using active constituents from Curcuma longa L. waste leaf: An Integrated Bioinformatics and Docking Study

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Abstract

The rapid rise in electronic waste (e-waste) has increased environmental exposure to metal oxide nanoparticles (NPs) such as ZnO, NiO, Al_2O_3, TiO_2 and CuO. Their high reactivity, while valuable for industrial applications, poses serious risks to human health. Epithelial cells are the very first line of defense to come into direct contact and are especially vulnerable to NP-induced inflammation and cellular stress. In the current study, we address two challenges: nanotoxicity arising from metal oxide nanoparticles commonly derived from e-waste, and the valorization of discarded Curcuma longa L. (turmeric) leaves, an underutilized agro-waste. Differentially expressed genes (DEGs) associated with NP exposure were identified from NCBI-GEO datasets via GEO2R analysis. Key hub genes involved in NP-induced toxicity were obtained through STRING-based protein-protein interaction analysis and Cytoscape evaluation. Further, reactome pathways enrichment analysis indicates that majority of DEGs are liked with cell cycle and DNA synthesis. Gene ontology analysis reveals that these genes are associated with DNA replication (GO BP), nuclear chromosome (GO CC) and catalytic activity as well as acting on DNA (GO MF). Active phytoconstituents extracted from waste C. longa leaves were docked with the hub genes using AutoDock Vina to assess their therapeutic potential. Among the major compounds of C. longa, Thymol demonstrated the binding affinity -6.10 kcal/mol against detected hub genes i.e. Cdc6, Cdk1, Plk1, Ccnb1, Ccna2 and MCM4. qRT-PCR validation further confirmed their modulatory effects on hub gene expression. This study provides a dual environmental benefit by elucidating the molecular impact of e-waste derived nanoparticles on epithelial health and showcasing turmeric leaf waste as a sustainable source of bioactive compounds capable of mitigating nanotoxicity.

Keywords: Metal oxide nanoparticles, Nanotoxicity, DEGs, Protein-protein interaction (PPI), Curcuma longa L. leaf waste, Molecular docking

Fabrication Of A Novel Olanzapine Nanoparticulate Delivery Platform: Optimisation And In Vivo Evaluation

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Abstract

Olanzapine (OLZ) is an antipsychotic drug commonly used in the management of schizophrenia and related psychiatric disorders. The present work aims to fabricate and optimise a novel OLZ nanoparticulate delivery system using high-pressure homogenization followed by freeze drying (lyophilisation). The Quality by Design (QbD) approach was employed to investigate critical formulation variables and identify the optimised formulation of OLZ-loaded oligosaccharide chitosan nanoparticles cross-linked with Eudragit RS 100 (OLZ-OSC-EUD NPs). The optimised OLZ-OSC-EUD NPs were characterised by Fourier-transform infrared spectroscopy (FTIR), differential Scanning calorimetry (DSC), X-ray diffraction (XRD), and scanning electron microscopy (SEM) to evaluate excipient compatibility, thermal behaviour, crystallinity and surface morphology.

The optimised formulation exhibited a mean particle size of 163.2 ± 1.2 nm, a polydispersity index (PDI) of 0.234 ±0.02, and an entrapment efficiency of 89.6 ± 2.21%. In vitro drug release study demonstrated a controlled-release profile, with 49.73% OLZ released in 8h and 91.32% over 24h, compared with 93.33% release from pure OLZ within 8h. In Ex Vivo nasal permeation studies, 95.41% permeation was observed within 24h, indicating nasal mucosal permeation. Furthermore, a three-month stability study at 4 ± 2 °C showed minimal changes in particle size, PDI, and encapsulation efficiency, indicating good stability of our developed formulation. Overall findings suggest that the developed OLZ-OSC-EUD nanoparticle platform is a promising intranasal formulation for the controlled release of olanzapine.

Keywords: Olanzapine, Nanoparticles, High-Pressure Homogenization, Box Benken Design, Lyophilisation, Nose to Barin delivery

Peptide Biologics In Cancer Nanomedicine: Tachyplesin As A Cell-penetrating Antimicrobial Peptide Nanocarrier For Anti-mir210 Delivery In Glioblastoma

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Abstract

Peptide biologics represent a versatile and rapidly expanding class of therapeutics at the interface of cancer nanomedicine, combining the biocompatibility and tunability of nanocarriers with the intrinsic membrane-targeting properties of naturally derived peptides. Antimicrobial peptides (AMPs) and cell-penetrating peptides (CPPs) share a common cationic, amphipathic architecture that confers both membrane-crossing ability and selectivity for the anionic membrane signature characteristic of cancer cells, positioning this peptide class as a promising platform for tumor-targeted drug and nucleic acid delivery. Tachyplesin, a disulfide-stabilized β-hairpin antimicrobial peptide (AMP) from horseshoe crab haemocytes, has been repurposed for its cell-penetrating (CPP) function and demonstrated as an efficient nanocarrier for anti-miR210 delivery in glioblastoma (GBM), achieving ~90% knockdown of this oncogenic microRNA, restoration of tumor-suppressor targets (NeuroD2, HIF3A), significant inhibition of proliferation, migration, and spheroid growth, induction of apoptosis, and synergistic sensitization to temozolomide. While these findings establish the therapeutic potential of peptide-based nanocarriers, current formulations largely rely on passive cancer-cell selectivity via electrostatic and membrane-composition differences, without active tumor-targeting or microenvironment-responsive control. Building on this evidence base, we outline a conceptual strategy to engineer the Tpl nanocarrier for next-generation, actively-targeted delivery, proposing: (i) conjugation of tumor-specific ligands to enhance receptor-mediated selectivity; (ii) incorporation of pH- or enzyme-responsive linkers to restrict peptide activation to the tumor microenvironment, minimizing off-target effects; and (iii) extension toward combinatorial RNA cargo delivery to simultaneously target multiple oncogenic pathways, offering a pathway toward more selective and multi-targeted peptide-based therapeutics for glioblastoma and other solid tumors.

Keywords: Peptide biologics, Cancer nanomedicine, Cell-penetrating peptides, Antimicrobial peptides, Nanocarrier, Glioblastoma, MicroRNA delivery

3D Solid-state Interdigitated Capacitive Electrodes: A Numerical And Simulation Study for Potential Sensing Applications

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Abstract

The sensitivity of solid-state interdigitated electrode (IDE) sensors strongly depends on geometric parameters- such as gap size, fringe width, and fringe number- which dictate electrostatic field distribution, minimise parasitic losses, and enhance signal-to-noise ratios. The planar configuration of IDEs localises the electric field, amplifying interfacial dielectric shifts during impedance analysis for trace analyte detection. In this study, finite element method (FEM) simulations using COMSOL Multiphysics were conducted to evaluate the impact of varied IDE geometric parameters on electrostatic transduction performance. Among the evaluated configurations, an optimal design featuring a 0.1 mm gap size, 0.1 mm fringe width, 16 no. of fringes, and a 43.4 mm2 active area achieved a peak electric field strength of 10,450 V/m. Results confirm that scaling down gap size and fringe width significantly amplifies electric field intensity, directly improving detection sensitivity. Furthermore, the micro-scale impedance behaviour was validated using an equivalent electrical circuit model accounting for bulk resistance and interfacial dielectric capacitance. These computational insights establish concrete design guidelines for developing high-resolution, real-time, non-destructive capacitive sensors.

Keywords: Finite Element Method, Solid-state, Simulation, Electrical Impedance Spectroscopy, Interdigitated Electrodes, Geometric parameters, optimisation.

Cheminformatics-Driven Optimisation of Molecularly Imprinted Copper Ferrite Nanocomposites for the Detection of C-Reactive Protein

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Abstract

C-reactive protein (CRP) is a well-established inflammatory biomarker widely used for the diagnosis and monitoring of infections, cardiovascular, neurodegenerative diseases, autoimmune disorders, and other inflammatory conditions. The development of rapid, selective, and cost-effective sensing platforms for CRP remains an important challenge in clinical diagnostics. This study proposes the chemoinformatics-guided design and optimisation of molecularly imprinted polymer (MIP)-coated copper ferrite (CuFe O) nanocomposites for the highly selective detection of CRP. Chemoinformatics tools are employed to investigate molecular interactions among CRP-derived template regions, functional monomers, and cross-linkers, enabling the rational selection of polymer components with enhanced binding affinity and specificity. Copper ferrite nanoparticles serve as the magnetic and electroactive core, providing a high surface area, excellent chemical stability, and improved electron-transfer properties, while the molecularly imprinted polymer layer creates selective recognition cavities complementary to the target biomarker. CRP is detected using electrochemical impedance spectroscopy (EIS) and cyclic voltammetry (CV). The modified electrode is more selective and sensitive for CRP due to its unique properties, with a regression coefficient of 0.98906, linearity of 0.5-100 ng/mL, sensitivity of 5.5628, and a limit of detection (LOD) of 0.032 ng/ml. This multidisciplinary strategy offers a promising platform for the development of robust, low-cost, and highly selective electrochemical biosensors for CRP, with potential applications in point-of-care diagnostics and early disease monitoring.

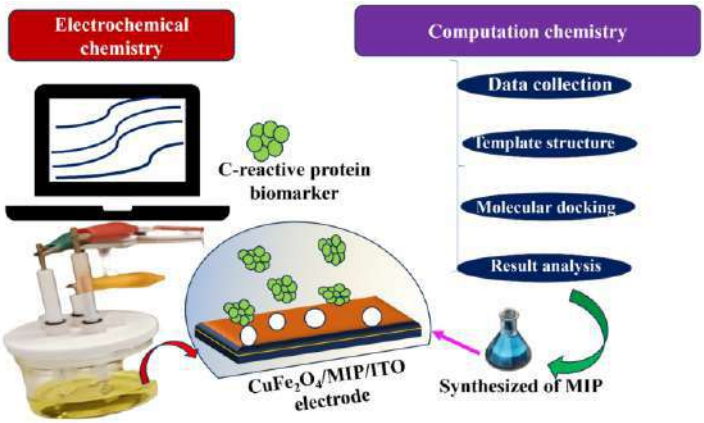


Figure 1. Graphical abstract.

Keywords: Molecularly imprinted polymer, Chemoinformatic, Copper ferrite, C-reactive protein, Nanoparticle, cyclic voltammetry.

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Microsponge Based Drug Delivery Systems: Recent Developments, Characterisation Approaches, Therapeutic Applications, and Future Perspectives

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Abstract

Background: The Microsponge Drug Delivery System (MDDS) has emerged as a versatile and advanced drug delivery platform capable of overcoming the limitations of conventional dosage forms. Its highly porous polymeric architecture enables controlled and site-specific drug release, improves drug stability, enhances bioavailability, minimizes dose-related adverse effects, and promotes patient compliance.

Objective: This study focuses on recent developments in microsponge technology, emphasizing formulation strategies, preparation techniques, physicochemical characterization, drug release mechanisms, therapeutic applications, marketed products, and recent patent trends.

Methods: Various fabrication approaches are discussed, including Liquid-liquid suspension polymerization, Quasi-emulsion solvent diffusion, Water in-oil-in-water (w/o/w) emulsion solvent diffusion, Addition of porogen,Oil-in-oil (o/o) emulsion solvent diffusion, Lyophilization,Vibrating orifice aerosol generator (VOAG) method,Ultrasound-assisted production,Electrohydrodynamic atomization method Applications: The review highlights the expanding applications of MDDS in topical, oral, gastroretentive, transdermal, tissue engineering, and targeted drug delivery systems. Recent patent advancements demonstrate increasing industrial interest and the translational potential of microsponge based formulations.

Methods: Various fabrication approaches are discussed, including Liquid-liquid suspension polymerization, Quasi-emulsion solvent diffusion, Water in-oil-in-water (w/o/w) emulsion solvent diffusion,Addition of porogen,Oil-in-oil (o/o) emulsion solvent diffusion, Lyophilization,Vibrating orifice aerosol generator (VOAG) method,Ultrasound-assisted production,Electrohydrodynamic atomization method Applications: The review highlights the expanding applications of MDDS in topical, oral, gastroretentive, transdermal, tissue engineering, and targeted drug delivery systems. Recent patent advancements demonstrate increasing industrial interest and the translational potential of microsponge based formulations.

Conclusion: Overall, MDDS represents a promising and adaptable drug delivery system with significant potential to enhance therapeutic efficacy and facilitate the development of safe, effective, and patient-centric formulations.

Keywords: Microsponge Drug Delivery System, Controlled Release Formulation, Targeted Drug Delivery, Topical Formulation, Gastroretentive Formulation, Patent Trends

Quantitative estimation of centellosides and other phytochemicals in Centella asiatica (L). Urban accessions collected from North East, India

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Abstract

Centella asiatica (L.) Urban (family Apiaceae) commonly known as Gotu Kola, Asiatic pennywort or Indian pennywort is a well explored medicinal plant. It is widely utilized in Western herbal medicine, traditional African medicine, traditional Chinese medicine, Ayurvedic medicine, and Western orthodox medicine. The plant has a good potential for use in pharmaceuticals, neutraceuticals and cosmetics . It is primarily used in Indian systems of medicine for reviving nerves and brain cells, and is thus known as a 'brain food' in India. Considering its medicinal utility and climatic suitability in NER, we collected 20 accessions of C. asiatica from different part of north east India. The accessions were compared with the released variety by ICAR- Indian Institute of Horticultural Research, Bengaluru (IIHR-Arka Divya and IIHR-Arka Prabhavi). After comparing the two released varieties of Bangalore, the result shows that Arka Divya was better in terms of morphological characteristic and higher in chlorophyll content as compared to Arka Prabhavi. Among the accession MZU/CA/04-04 was slightly better in morphological characteristic than the other accession collected from North eastern state. In terms of chlorophyll content MZU/CA/09-01shows higher chlorophyll content than the other accession collected from North eastern state. C.asiatica (L) phytochemical screening was investigated by using methanol to extract the powdered dry leaves. The phytochemical analysis of the extracts was performed using standard protocol for both quantitative and qualitative. Preliminary phytochemical analysis shows the presence of seven compounds such as phenols, tannins, terpenoids, alkaloids, flavanoids, cardiac glycosides and saponins. The findings imply that C.asiatica (L) leaves are a rich source of important secondary metabolites. We also measured the centellosides, the major triterpenoid saponins present in Centella asiatica, the principal centellosides include asiaticoside, madecassoside, asiatic acid and madecassic acid by HPLC. Thus, these compounds are important for the phytochemical standardization and therapeutic evaluation of C. asiatica.

Keywords: Centella asiatica, morphology, phytochemical, madecassoside, asiaticoside, madecassic acid, asiatic acid.

Dna Nanotechnology Based Emerging Technologies for Biological And Biomedical Applications

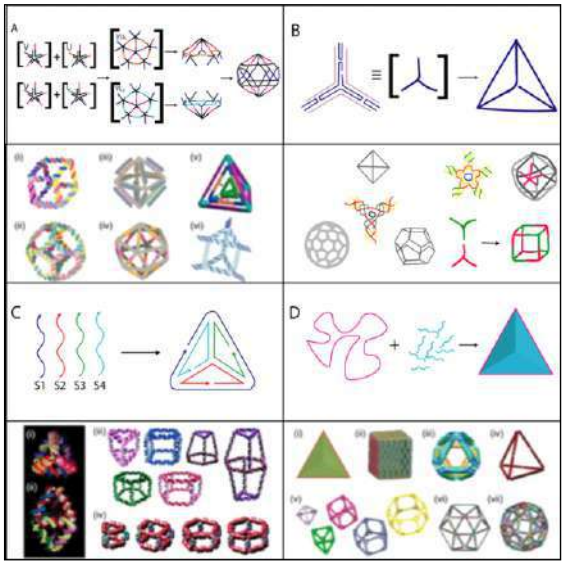
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Abstract

Prof. Bhatia's laboratory investigates how nanometer-sized biomolecules transmit and integrate information across much larger length scales such as cells and tissues. Our aim is to explore how collections of macromolecules work together to establish functional systems like cellular pathways, organelles, living cells, tissues, organs and entire organisms. Different biomolecules establish long-range order in living systems by self-assembling into larger structures including molecular complexes, membranes, and cytoskeletal organelles, intra- and inter-cellular contacts. The main theme of our lab is to understand the assembly principles of biological systems and the roles these structures play in living cells, tissues and organisms. Furthermore, We seek to develop technologies to modulate these systems. To address these challenges, we adapt a multidisciplinary, bottom-up approach using DNA nanotechnology. DNA offers immense potential to organize matter at the nanoscale with extreme robustness and spatial specificity. The compatibility of DNA to interface with other biomolecules like proteins, carbohydrates, lipids, and small molecules makes DNA a natural choice of material for bottom-up self-assembly. Thus, we integrate the complex programmability of DNA nanotechnology with the structural and functional diversity of other biomolecules. Our interdisciplinary research, along with national and international collaborations with experts, will leverage expertise from chemistry, nanotechnology, biophysics, biology, engineering, and medicine. The overarching goal of the Prof. Bhatia's team is to translate laboratory findings into the development of new therapeutic strategies.

Keywords: DNA nanotechnology, self-assembling, specificity



Various 3D DNA based nanocages have been Realized based on one-pot, modular and Origami based approaches

Future directions – To develop DNA Nanotechnology based materials for Clinical and Healthcare applications

Corts 1:A Multifunctional Corneal-targeting Peptide For Targeted Ocular Drug Delivery And Antimicrobial Therapy

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Abstract

Delivery of therapeutics to the ocular tissues is challenging due to various anatomical and physiological barriers imposed. Cell penetrating peptides (CPPs) have emerged as potent drug nanocarriers that have been shown to overcome these barriers and enhance bioavailability of therapeutic macromolecules in deep ocular tissue. Corneal Targeting Sequence 1 (CorTS 1) was developed as a multifunctional peptide designed to combine corneal targeting, cellular penetration, and antimicrobial activity. The variable residues of the LRR motif were replaced with arginine residues to enhance cellular penetration, generating the sequence LRRLRLRRNRL-NH . CorTS 1 exhibited a random-coil structure in aqueous solution and showed evidence of interaction with collagen. CorTS 1 exhibited dose dependent cellular translocation from 5 µM in Human Corneal Epithelial cell line (HCE) with no cytotoxicity. CorTS 1 was also found to deliver protein cargo inside HCE cells. In preliminary studies, the peptide demonstrated notable retention in goat corneal tissue and exhibited significant inhibitory activity against Fusarium dimerum spores, while showing no adverse effects on the viability of human corneal epithelial cells. Interestingly, CorTS 1 also showed an antimicrobial activity against MRSA and Fusarium dimerum. Therefore, CorTS 1 can be a multifunctional corneal-targeting peptide with antimicrobial activity and nanocarrier for ocular drugs.

Keywords: Cell penetrating peptides, ocular drug delivery, Corneal targeting sequence, LRR motif, Fusarium dimerum, MRSA

Synthesis and Characterization of a Magnetized Biopolymer Nanocomposite for Dielectric Energy-Storage Applications

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Abstract

Magnetically responsive nanocomposites based on biopolymer components have emerged as promising candidates for energy storage devices owing to their tunable dielectric/conductive nature. This paper reports the synthesis and characterization of magnetically responsive biopolymer composite consisting of acacia gum-coated magnetite nanoparticles and alumina, copper iodide, polyaniline and graphene oxide (MAG–Al O –CuI–PANI–GO) through sequential process of co-precipitation, in situ oxidative polymerization and solution mixing method. First, Fe O nanoparticles were prepared through co-precipitation method of Fe^{3} /Fe^{2} precursors in the presence of acacia gum as a green capping agent, further hybridizing with Al O –CuI–PANI and GO to produce the biopolymer-based five-phase nanocomposite. The structural, morphological and functional characteristics of nanocomposite were evaluated through different methods. X-ray diffraction (XRD) (Fig.2(a)) confirmed the existence of spinel phase of Fe O , unique reflection band of GO and crystalline Al O –CuI–PANI in the pattern of nanocomposite, demonstrating multiphasic nature of the composite. Fourier transform infrared (FTIR) spectroscopy validated the presence of Fe–O bonds, polyaniline backbone (C=C/C–N) and oxygen-functional groups of GO in the spectrum (Fig.2(b)). Raman spectroscopy showed sharp bands at 1339 cm^{1} (D) and 1598 cm^{1} (G), suggesting the presence of graphitic/graphene oxide structure in the nanocomposite. N adsorption/desorption isotherms presented a Type IV isotherm with H3 hysteresis loop, denoting mesoporous structure of nanocomposite. Magnetic behaviour was assessed through vibrating sample magnetometry, exhibiting a saturation magnetization of 6 emu/g in ±20 kOe field strength and low-field region with negligible coercivity and remanence for easy magnetic separation/recovery of nanocomposite through external magnet. Thermogravimetric analysis (TGA) showed multiple steps of weight loss at 800°C, giving a residual mass of 67%, representing the good thermal stability of nanocomposite. Zeta potential analysis gave a point of zero charge (pH_ZPC) of 5.46, with surface charge of −13.6 mV at measured pH, related to adsorption. Micrographs of field-emission scanning electron microscopy (FESEM) showed an irregular agglomeration of nanogranular surface, where there were GO sheets coated with fine nanoparticles, suggesting the successful synthesis of composite. Energy-dispersive X-ray (EDX) confirmed the presence of C, O and Fe elements (59%, 36% and 5%, respectively), supporting the incorporation of Fe O into carbonaceous framework. High-resolution transmission electron microscopy (HRTEM) images presented spherical Fe O nanoparticles (dark contrast) within the translucent wrinkled GO/polymer framework, confirming uniform dispersion of magnetic nanoparticles in the composite.

Keywords: Acacia gum, Fe_3O_4, graphene oxide, polyaniline, nanocomposite, dielectric relaxation, energy storage

Target-mediated Interfacial Shielding on Nanoprobe For Rapid Colorimetric Detection of Cardiac Biomarkers

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Abstract

Rapid detection of cardiac biomarkers is critical for timely diagnosis and management of acute cardiovascular diseases, however conventional immunoassays often suffer from slow response, limited sensitivity, and low adaptability to point-of-care detection. Herein, we developed a colorimetric assay based on a target-induced shielding at a dual-affinity probe interface for detection of cardiac troponin I (cTnI) and N-terminal pro-B-type natriuretic peptide (NT-proBNP). Both biomarkers are clinically relevant gold standard biomarkers of acute myocardial infarction (AMI) and heart failure (HF). The assay leverages on dual-affinity probe that act as an inhibitor to the enzyme (urease) and have the co-presence on its surface of affinity molecules against biomarkers. Upon addition of target biomarker, the probe selectively binds to it and a shielding layer is formed that renders the enzyme free in solution. Consequently, the activity of enzyme generates a pink-colored end-point for visual detection in <15 min. Comprehensive biophysical characterization using microscale thermophoresis (MST) and isothermal titration calorimetry (ITC) confirmed strong target-probe interactions and elucidated the shielding mechanism. Importantly, the assay demonstrated negligible interference in complex biological matrices, maintaining analytical performance in MST up to 50% human serum. The platform achieved a detection limit as low as 0.088 ng/mL for cTnI, and 0.1 ng/mL for NT-proBNP with high specificity, reproducibility. The robustness of assay highlights its translational potential for rapid, visual, point-of-care and cost-effective diagnostic platform, particularly for resource-limited settings. It also offers a versatile framework adaptable to diverse protein biomarkers in nano diagnostics applications.

Keywords: Dual-affinity probe, point-of-care diagnostics, colorimetric assay, cardiac biomarkers, Probe shielding layer, rapid

Ciprofloxacin Induced Stevens–Johnson Syndrome-Toxic Epidermal Necrolysis (SJS-TEN) Overlap in Young Female with Systemic Lupus Erythematosus : A Rare Case Report With Literature Review.

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Abstract

Stevens–Johnson syndrome (SJS) and toxic epidermal necrolysis (TEN) are severe mucocutaneous adverse drug reactions. Fluoroquinolone-induced SJS/TEN is uncommon, and its occurrence in patients with Systemic lupus erythematosus (SLE) may create significant diagnostic challenges because lupus flares can mimic severe cutaneous drug reactions.

Case Presentation: We Report a case of a 17-year young female, a known case of SLE with poor treatment adherence and loss to follow-up, presented with acute onset of fever, widespread erythematous rash, mucosal involvement, and epidermal detachment following ciprofloxacin use. The skin involvement was estimated at 11–29% of body surface area, consistent with SJS-TEN overlap. Initial evaluation considered both severe cutaneous lupus manifestations and SJS/TEN. Detailed history revealed recent ciprofloxacin exposure preceding symptom onset. The patient was managed with immediate withdrawal of the suspected drug, supportive care, and immune-modulatory therapy. Clinical improvement was subsequently observed.

Conclusion: This case highlights the importance of meticulous drug history in patients with autoimmune diseases presenting with extensive mucocutaneous lesions and Potential for Ciprofloxacin to induce SJS. Ciprofloxacin-induced SJS-TEN overlap in an adolescent with SLE is rare and poses a significant diagnostic challenge.

Keywords: Stevens–Johnson syndrome (SJS), Ciprofloxacin, toxic epidermal necrolysis (TEN), SCROTEN, Systemic Lupus Erythematosus, Drug- Induced Skin Reaction.

Development of Tumor Microenvironment-modifying Nanoparticles for Multimodal Cancer Cell Killing In Vitro

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Abstract

Cancer is one of the leading causes of death worldwide. The conventional treatment approaches, such as chemotherapy, surgery, and radiotherapy, are often limited by their own limitations, including non-specificity, resistance, recurrence, and systemic toxicity. Recent advancements in nanotechnology led to the development of new therapeutic approaches like photothermal therapy, photodynamic therapy, chemodynamic therapy, etc. However, monotherapeutic approaches are failing to remove tumours completely, and their efficacy is limited by the characteristic tumour microenvironment. To address these challenges, this work focuses on the development of tumour microenvironment-modifying nanoparticles through integrating multimodal therapeutic strategies to cause cancer cell-specific toxicity through synergistic effect. We report manganese oxide (MnO)–based1 and titanium carbide (Ti_3C_2 MXene)–based2 nanocomposites designed to enable chemodynamic therapy (CDT), photodynamic therapy (PDT), photothermal therapy (PTT), and glucose starvation therapy (GST) within the tumour microenvironment.

Keywords: Cancer therapy, Glucose-mediated starvation, Cascade reaction, Chemodynamic therapy, Phototherapy.

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Fabrication Of Anti-egfr-grafted Lipid Nanoparticles For Effective Delivery Of Anti-cancer Drug: A Multifaceted Approach Combating Breast Cancer

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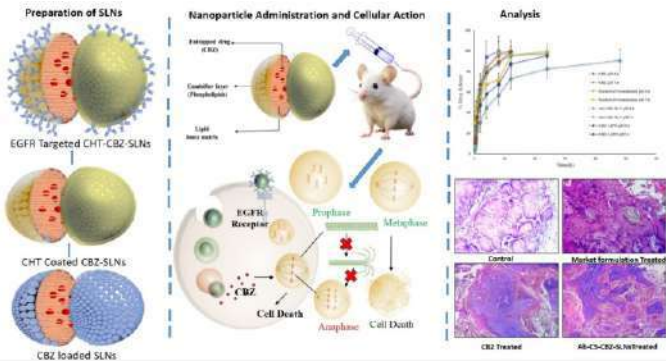
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Abstract

Cabazitaxel, US-FDA synthetic taxane has been highly recognized in treatment of metastatic prostate cancer. Clinical evidences show the drug also exhibit potency in treatment of breast cancer. Despite numerous advantages this drug undergoes various challenges like low solubility, poor drug permeation, rapid plasma clearance.

Objectives: This study focuses on designing nanotechnology based targeted drug delivery system for repurposing of drug and reducing its challenges for the treatment of breast cancer.

Methods: The work involve preparation and optimization of solid lipid nanoparticle using solvent evaporation method. This formulation was further modified using chitosan for enhancing stability and further coated with EGFR for targeted delivery



Results: Characterization studies revealed that the SLNs had a particle size of 220±0.75 nm with a drug entrapment efficiency of 89.42±0.35%. On comparison with the marketed formulation the studies reveal that invitro release of the formulation offered a higher drug release rate at pH 5.6 (88.89%) than at pH 7.4 .The lipidic formulation showed lower IC50,values in breast cancer cell lines MDA-MB231 in comparison with the plain and marketed formulations. The 3D model spheroids based studies have also confirmed that formulation exhibits more than 7 times more efficacy than plain cabazitaxel and 5 times than marketed formulations. Moreover, hemolysis studies revealed the blood compatible nature of the nanoconjugate, indicating its safety for intravenous administration Pharmacokinetic studies showed that the developed system offered higher bioavailability and decreased drug clearance from the system compared to the plain drug.

Conclusion: The comprehensive data reveals that EGFR-targeted nanoformulation significantly improved the safety and efficacy of cabazitaxel in combating breast cancer.

Keywords: Drug Delivery, Bioavailability, Monoclonal Antibody , Pharmacokinetics, Anticancer

Designing And Fabrication Of Microfluidic Paper Based Analytical Device (μpad) For Liver Cancer Diagnosis

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Abstract

This study describes the designing and fabrication of a μPAD for cancer diagnosis. The design of device has been created using Inkscape software followed by the stencil-based patterning for precise fabrication and development of device. The electrochemical technique has been combined with the developed device for on-site detection of liver cancer biomarker, Annexin A2 (ANAX-2). The μPAD platform employs the significant advantages in order to detect electrochemical signals, possess greater sensitivity, provide rapid response, and consume low sample volume which makes appropriate for low volume analysis such as in microlitres where amplification of signal becomes difficult. Whatman filter paper which a cellulose based substrate was finalized for the development μPAD because of its outstanding properties like admirable capillary-driven action, good flexibility, cost effectiveness, and easy disposal. Stencil-based designing has been used to create microfluidic channels and hydrophobic barriers, allowing for controlled movement of fluids and consistent assay conditions. The working electrode has been integrated within the μPAD using optimised ratio of Poly(3,4-ethylenedioxythiophene): poly(styrene sulfonate) (PEDOT:PSS) and phosphorus-doped graphitic carbon nitride (P-g-C N) to make electrically conducting. Anti-Annexin A2 has been subsequently immobilized on the modified electrode surface through established coupling chemistry, followed by addition of bovine serum albumin (BSA) over electrode surface for blocking to suppress non-specific binding and improve assay selectivity. Comprehensive physicochemical and morphological characterization have been performed, while electrochemical behaviours have been evaluated via chronoamperometry technique. The developed μPAD showed a broad linear range of detection from 100 pg mL ¹ to 500 μg mL ¹, with a high sensitivity of 1.8 μA [log(ng mL ¹)] ¹ cm ² and excellent limit of detection i.e. 100 pg mL ¹ with analytical sample volume of only 10μL. These results highlight the device's capability for precise, low-volume biomarker quantification. Additionally, we tested the electrochemical response of the developed biosensor using spiked ANXA 2 serum samples, and the results showed a significant association with the standard ANXA 2 samples.

Keywords: Liver cancer, Annexin A2, μPAD, Biosensor, Electrochemical, graphitic carbon nitride.

3d Printed Screw Shaped Microneedles For Elelctrochemical Vitamin D3 Sensing In Interstitial Fluid

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Abstract

Clinical research consistently demonstrates that individuals are diagnosed with vitamin D3 insufficiency, which can lead to various skeletal abnormalities, immunological disorders, neurological diseases, and cardiovascular disease [1]. Therefore, early detection of vitamin D3 insufficiency is essential due to its critical function in homeostasis and association with numerous diseases. But since current methods are expensive, time-consuming, and complex, measuring vitamin D3 levels is difficult, especially in rural areas. In light of the interstitial fluid (ISF), wearable dermal patches based on microneedle (MN) device have received alot of attention lately [2]. In this work, we have developed a Masked Stereolithography (MSLA) 3D-printed biocompatible microneedle skin patch as point-of-care electrochemical device for determination of vitamin D3 as high precision technology approach for microneedles fabrication. The microneedles was then made conductive using PEDOT-PSS-borophene nanocomposite coating and used for the development of working and counter electrodes. The designed microneedle array-based skin patch was investigated for vitamin D3 sensing following physical and electrochemical characterizations. With a broad linear detection range of 0.1–200 µM, the analytical results demonstrated superior sensitivity and specificity toward vitamin D3. The constructed MN array-based sensor can readily detect the Vit D3 micromolar levels in artificial ISF, as demonstrated by the proof-of-concept findings from the skin-mimicking model; this kind of system can be explored more thoroughly for the fabrication of various other kinds of vitamins too.

Keywords: 3D Printed, Microneedles, Interstitial fluid, Vitamin D3, Electrochemical detection, Screw shaped

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Design, In Silico Evaluation, And Synthesis Of Coumarin Based Hybrid Derivatives As Potential Neurotherapeutics.

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Abstract

Neurodegenerative disorders, including Alzheimer's disease, Parkinson's disease, Huntington's disease, and amyotrophic lateral sclerosis, are characterized by progressive neuronal loss and impaired cognitive and motor functions. Despite significant advances in understanding their pathophysiology, effective therapeutic interventions remain limited. Coumarin, a naturally occurring benzopyrone scaffold, has gained considerable attention in medicinal chemistry due to its diverse pharmacological activities, including antioxidant, anti-inflammatory, metal-chelating, and neuroprotective properties. In the present study, a series of novel coumarin-based hybrid compounds were designed and synthesized with the aim of developing potential therapeutic agents against neurodegenerative diseases. Computational investigations, including molecular docking, ADMET prediction, and drug-likeness evaluation, were performed to assess the interaction of the designed hybrids with key neurodegenerative targets such as acetylcholinesterase (AChE), monoamine oxidase-B (MAO-B). The in-silico results demonstrated favourable binding affinities and significant interactions with crucial amino acid residues within the active sites of the selected targets. The synthesized compounds were characterized using spectroscopic techniques including FT-IR, 1H NMR, 13C NMR, and mass spectrometry. Structure-activity relationship analysis revealed that hybridization of the coumarin scaffold with pharmacologically active moieties enhanced target binding and predicted pharmacokinetic properties. The findings suggest that coumarin-based hybrid molecules possess promising neuroprotective potential and may serve as lead candidates for the development of multifunctional therapeutics for neurodegenerative disorders. Further in vitro and in vivo investigations are needed to validate their efficacy and safety profiles.

Keywords: Coumarin hybrids, Neurodegenerative diseases, Molecular docking, In-silico studies, Neuroprotection, Drug design, ADMET, Medicinal chemistry.

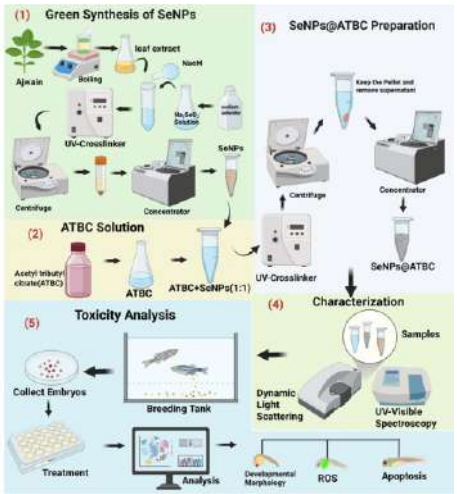
Developmental Toxicity Of Senps@atbc Conjugate Showcased By Intrinsic Interactions Driving Oxidative Stress And Apoptosis In Zebrafish Embryos

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Abstract

In recent years, the use of engineered nanomaterials and alternative plasticizers has led to a new environmental concern, in which possibility interaction and co-occurrence of plasticizers and nanomaterials in aquatic systems. However, the effects of their simultaneous exposure on biology are poorly understood. In the current study, SeNPs@ATBC conjugates were used as a representative model of nanomaterial-plasticizer co-contamination, and the focus was given to their developmental toxicity and underlying molecular mechanisms using computational approaches in zebrafish (Danio rerio) embryos. The SeNPs, ATBC, and SeNPs@ATBC were synthesized using a green and sustainable approach where ajwain (Trachyspermum ammi) leaf extract serves as a reducing agent along with a stabilizing/capping agent. Afterwards, the as-synthesized composites were characterized for physicochemical properties using UV-Vis spectroscopy, FTIR, SEM with EDX, and zeta potential analyzers to understand their potential effect on biological interactions. The zebrafish embryos were treated with SeNPs, ATBC, and SeNPs@ATBC from 10 to 500 µgmL-1 and analyzed for developmental changes up to 72 hpf. Assessment included survival, hatching success, cardiac activity, and characteristic developmental abnormalities, including pericardial edema and yolk-sac swelling, spinal malformations, and developmental delay. The results showed low developmental toxicity for the green-synthesized SeNPs at low concentrations, while ATBC resulted in moderate developmental toxicity. Notably, the SeNPs@ATBC conjugates were found to be highly concentration-dependent in their toxicity effects, as evidenced by higher embryonic mortality, delayed hatching, changes in cardiac activity, and increased morphological abnormalities at higher concentrations. Mechanistic studies revealed increased generation of reactive oxygen species (ROS) and activation of apoptotic responses in hypoxic conditions caused by the attachment and accumulation of the SeNP@ATBC conjugate in the chorion. These differential toxicities of the individual components and their conjugated form indicate that interactions between SeNPs and ATBC could modify the bioavailability, cellular uptake, and biological reactivity of contaminants, leading to additive or synergistic developmental effects. Overall, this study explores a novel insight into the toxicological interface between engineered SeNPs and the plasticizers. The results highlight the importance of evaluating contaminant interactions rather than individual chemicals for developmental risks of emerging nanomaterial-plasticizer mixtures involving environmental and human health effects.



Keywords: Nanomaterial, plasticizer, co-contamination, Green synthesis, Oxidative stress, Apoptosis, Zebrafish embryo

Nanotoxicology of Bhasma(Ayurvedic Herbo-Metallic Nanoparticles) Safety and Toxicity Evidence

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Abstract

Bhasmas are Ayurvedic herbo-metallic preparations produced through purification (shodhana) and repeated incineration (marana) of metals and minerals, yielding particles in the nano- to micrometer range. A central premise of bhasma nanotoxicology is that this processing detoxifies the parent metal and converts it into a biocompatible, therapeutically active form, with particle sizes below 100 nm proposed to reduce host toxicity while enhancing bioavailability. The present review synthesizes preclinical safety and toxicity evidence across multiple bhasma types to evaluate the strength and consistency of this premise.

Results: TEM analysis of Yasada, Vanga, Naga, Swarna, Raupya, and Makardhwaja bhasmas confirmed sub-100 nm sizes consistent with reduced toxicity, whereas a separate study of commercial shankh, yashad, vanga, and iron bhasmas measured particle sizes of 260–2000 nm, likely reflecting aggregation in aged samples. This inconsistency indicates that nanoparticulate character cannot be assumed from product labeling alone and underscores the need for batch-level characterization. Across in vitro and in vivo models, properly prepared bhasmas of gold, zinc, iron, and lead consistently showed low toxicity at therapeutic doses. Swarna Bhasma produced no reduction in HeLa or HFF-1 cell viability and was nontoxic in rats at ten times the therapeutic dose, with zebrafish behavioral testing showing no neurotoxic effects. Jasada Bhasma (zinc oxide) showed an IC50 above 1000 µg/mL in Caco-2 cells, and Kasis Bhasma (iron) showed negligible cytotoxicity that decreased further with smaller crystallite size. Manikya Bhasma (arsenic-containing) was an exception, inducing dose-dependent apoptosis selectively in cancer cell lines rather than normal tissue. Comparative studies suggest that Ayurvedic processing lowers toxicity relative to the unprocessed metal nanoparticle: Mandur Bhasma was less inhibitory to yeast growth than equivalent iron nanoparticles, though herbally synthesized silver nanoparticles showed greater acute oral safety than marketed Rajat Bhasma in rats, indicating the direction of this effect is not uniform across metals. Key limitations temper these findings. Classical qualitative tests (Varitaratwa, Apunarbhava) are insufficient for safety determination, and complete physicochemical standardization is lacking. Instrumental neutron activation analysis of seventeen commercial bhasmas revealed wide variation in elemental composition even among products of the same nominal metal, depending on preparation method. All available safety evidence remains preclinical (Level 5) and hypothesis-generating, with no published randomized controlled trials or cohort studies, and formal pharmacovigilance protocols are still needed. Evidence broadly supports low toxicity of properly prepared bhasmas at therapeutic doses across multiple in vitro and in vivo models, but particle-size claims are inconsistent between studies, standardization is incomplete, and higher-level clinical safety data are absent. Robust batch-level physicochemical characterization and formal pharmacovigilance frameworks remain priorities for future research.

Keywords: Bhasma, Nanotoxicology, Herbo-metallic nanoparticles, Ayurvedic pharmaceutics, Preclinical safety Particle size characterization , Pharmacovigilance

Cow Urine Assisted Hydrothermal Synthesis and Characterization of Zinc Silver Nanocomposite (ZNO-AG2O)

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Abstract

The increasing demand for environmentally sustainable nanomaterials has encouraged the development of green synthesis methods using renewable biological resources. In the present study, Zinc Silver (ZnO-Ag2O) nano-composite was successfully synthesized through a green hydrothermal process using cow urine as a natural reducing, stabilizing, and complexing agent. The hydrothermal method provided controlled nucleation and crystal growth, resulting in highly crystalline nano-composite with improved structural and surface properties. The synthesised nano-composite was characterised by using FTIR, UV visible, SEM and TEM. The comprehensive characterization demonstrated the successful formation of ZnO-Ag2O nano-composite with nanoscale dimensions, high crystallinity, and homogeneous elemental distribution. The eco-friendly hydrothermal synthesis using cow urine offers a simple, cost-effective, and sustainable approach for producing multifunctional metal oxide nano-composite with enhanced physicochemical properties..

Keywords : Renewable, nanocomposite, stabilizing, nucleation, sustainable, physicochemica.

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Formulation And Characterisation Of Delafloxacin-loaded Ethosomes Via A Quality By Design

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Abstract

The present study involves the development and characterisation of ethosomes loaded with delafloxacin (DFX) for the topical delivery. The cold method was used to prepare the ethosomes, followed by their incorporation into the gel base. Quality by design was used to optimise the formulation using dependent variables such as particle size, PDI, and %EE. Particularly, the Box–Behnken design was used with the independent factors like soya PC and ethanol concentration, and stirring time. The optimised formulation showed a size less than 300nm, PDI less than 0.3, and %EE more than 90%. Smooth surface morphology was confirmed through FE-SEM. An in vitro drug release study revealed that the formulation showed controlled drug release with the Weibull kinetic models. The cytotoxic study on the NIH/3T3 cell line revealed. The prepared ethosomal gel favorable properties for the topical applications. The biocompatibility of the developed formulation was checked with the HET-CAM assay, as well as a skin irritation study. The ex vivo study demonstrated the higher permeation of DFX from the ethosomes than the free DFX solution. The antimicrobial study on both S aureus and C acnes revealed enhanced activity of the formulation compared to the free drug. Overall, the developed formulation improved antibacterial activity with the topical application.

Keywords: Topical Delivery, Quality by design, Ex vivo, Ethosomes, Delafloxacin.

Hesperidin-loaded Niosomal Vaginal In-situ Gel: A Novel Nanomedicine Approach for Polycystic Ovary Syndrome (PCOS)

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Abstract

Polycystic Ovary Syndrome (PCOS) is a common endocrine and metabolic disorder associated with hyperandrogenism, insulin resistance, oxidative stress, ovarian dysfunction, and impaired follicular development. Hesperidin, a naturally occurring citrus flavonoid, has shown antioxidant and anti-apoptotic effects that may be beneficial in PCOS-associated granulosa-cell dysfunction. However, its poor aqueous solubility and limited bioavailability can affect its effective delivery. The present work focuses on the development of a hesperidin-loaded niosomal thermosensitive vaginal in-situ gel to improve drug delivery and provide prolonged residence at the vaginal site. Hesperidin-loaded niosomes will be prepared using Span 60 and cholesterol and incorporated into a thermosensitive mucoadhesive gel containing Poloxamer 407 and HPMC K100M. Formulation variables will be optimized using a Box–Behnken design. The niosomes will be evaluated for vesicle size, polydispersity index, zeta potential, entrapment efficiency, and drug content, while the final gel will be assessed for pH, viscosity, rheological behaviour, gelation temperature, gelation time, mucoadhesive strength, syringeability, and in-vitro drug release. Based on findings reported for similar niosomal and thermosensitive vaginal delivery systems, the formulation is expected to show nanosized and relatively uniform vesicles with good hesperidin entrapment. The incorporation of niosomes into the thermosensitive gel is expected to provide suitable gelation at physiological temperature, better mucoadhesion, and controlled drug release. The combined system may help overcome the solubility and retention limitations of hesperidin and provide a more controlled delivery approach. Overall, this formulation represents a promising nanotechnology-based strategy for the localized and sustained delivery of hesperidin, with further experimental and biological studies required to establish its potential in PCOS management.

Keywords: Hesperidin; Niosomes; In-situ gel; PCOS; Nanomedicine; Bioavailability; Vaginal Drug Delivery

8-Hydroxyquinoline Functionalized Carbon Dot for Fe (III) Detection with Cellular Imaging

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Abstract

A particular class of nanomaterials: Carbon quantum dots (CDQs) have promising potential for application in biological imaging & sensing. These CDQs, known for their exceptional optical properties, biocompatibility, and ease of functionalization, offer a unique platform for creating customized nano-sensors for various purposes. This work demonstrates a unique approach by synthesizing 8-hydroxy quinoline functionalized carbon quantum dots (CD-AHQ) as a fluorescent nano-sensor for dual application: a) selective detection and, b) in vivo imaging of Fe (III) ions. The synthesis of CD-AHQ involved the hydrothermal method for preparing blue fluorescent carbon quantum dots and subsequent functionalization with 8-hydroxy quinoline ligands. The resulting CD-AHQ shows excellent water solubility, stability, and bio-compatibility, making them promising for sensing & biological applications. The microstructure and size of the produced CD-AHQ nano-sensor were investigated using various techniques such as High resolution - transmission electron microscopy (HR-TEM), dynamic light scattering (DLS), Fourier-transform infrared spectroscopy (FT-IR), XRD, XPS and selected area electron diffraction (SAED). TEM images confirms that the synthesized nano-sensor CD-AHQ are spherical in shape and having crystalline nature and the lattice distance is about 0.348nm. The XRD patterns supports the finding of the HR-TEM results, the broad diffraction peak observed at = 23.2o, correspond to (002) lattice plane of the carbon-based quantum dots having d-spacing of approx. 3.2 Å. The broad XRD peak of CdQs indicates the amorphous nature, small size of the particles and presence of more oxygen containing functional groups on the surface. The Raman spectra of CD-AHQ was recorded and it is showing two broad bands at 1362 cm− 1 and 1565 cm− 1 named as D-band and G-band respectively. The D band (sp3 hybridization) demonstrate the amount of functionalization of the CdQs and G band (sp2 hybridization) represents the amount of sp2 hybridized carbon atoms on the surface of nano-sensor. The ratio of G-band to D-band i.e. (IG/ID) is approximately 1.05 indicating that the carbon quantum dots are functionalized and having crystalline nature. Additionally, CD-AHQ demonstrates a high degree of selectivity for Fe3+ ions over other metal ions. This high selectivity is a testament to the precision and effectiveness of CD-AHQ. The feasibility of using CD-AHQ for in vivo imaging was tested in live MDA-MB-231 cells. Confocal fluorescence microscopy has shown efficient cellular uptake and specific intracellular localization of CD-AHQ, enabling real-time imaging of cells. The biocompatibility and low cytotoxicity of CD-AHQ further validated their suitability for bioimaging applications.

Keywords: Carbon quantum dots, Quinoline, Sensing, Bioimaging, Photoluminescence

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Mannosylated Gelatin Nano-in-microparticles For Targeted Inhalable Delivery Of Clofazimine In Pulmonary Tuberculosis

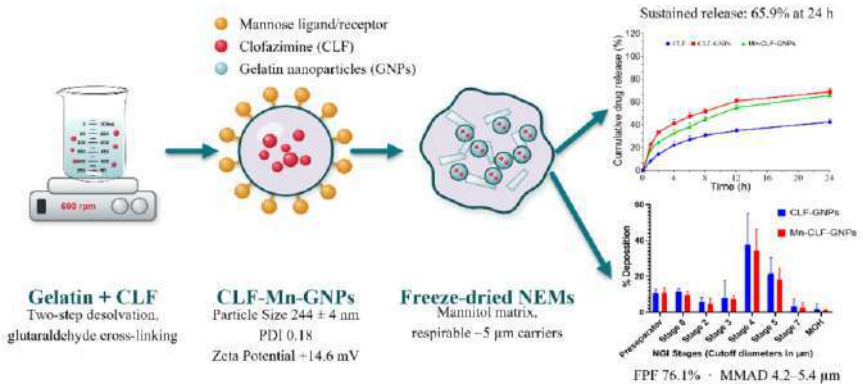
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Abstract

This study explores the therapeutic potential of gelatin nanoparticles (GNPs) as carriers for delivering clofazimine (CLF) to treat Mycobacterium tuberculosis. CLF, a second-line antitubercular drug, exhibit notable antimycobacterial and anti-inflammatory properties. However, its clinical efficacy is constrained by poor solubility and low bioavailability, which limit drug concentration at the target site. To address these challenges, we developed CLF-loaded mannosylated gelatin nanoparticles (CLF-Mg-GNPs) using a double desolvation technique for targeted delivery to alveolar macrophages. These nanoparticles were further processed into nano-in-microparticles using freeze-drying to optimise their suitability for pulmonary delivery. The optimised formulation, tailored for selective targeting of alveolar macrophages, exhibited a mean particle size of 244.2 ± 3.52 nm, a polydispersity index (PDI) of 0.151 ± 0.04, and a zeta potential of + 14.6 ± 0.55 mV. The product yields of freeze-dried CLF-GNPs and CLF-Mn-GNPs were 98.20% w/w and 93.43% w/w, respectively, with corresponding drug contents of 82.78 ± 0.43% and 78.13 ± 0.18%, respectively. In vitro drug release of pure CLF reached only 38.52% by 24 h, reflecting its limited bioavailability. In contrast, CLF-GNPs showed a significantly enhanced release of 68.92% by 24h. In comparison, CLF-Mn-GNPs exhibited a sustained release of 65.91 % by 24 h, underscoring the improved dissolution profile of the developed nanoformulation. Future studies will evaluate the in vivo efficacy and safety of this formulation in an appropriate animal model. The particulate engineering approach combines the advantages of nano-embedded microparticles (~5 µm), which facilitate pulmonary deposition by meeting aerodynamic and size requirements for lung delivery, with nanoparticles (~300 nm), which improve the dissolution profile of poorly soluble CLF. The optimised inhalable CLF-Mn-GNPs formulation exhibited favourable aerosol performance and sustained drug release, indicating its potential as an efficient pulmonary carrier that could reduce dosing frequency and systemic toxicity. In vivo studies are required to confirm these benefits. This finding underscores its potential as a promising approach for developing effective antitubercular therapies.

Keywords: Mannosylated gelatin nanoparticles, Clofazimine, Freeze Drying, Aerosolisation behaviour, Tuberculosis



Zeolitic Imidazolate Frameworks ZIF-67 and ZIF-8 As Protein-interactive Materials: Spectroscopic and Molecular Insights

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Abstract

Metal–organic frameworks (MOFs) have emerged as promising nanomaterials for biomedical and biochemical applications due to their high surface area, tunable porosity, and structural versatility. Among them, ZIF-8 and ZIF-67 have attracted significant attention for protein immobilization, drug delivery, and biosensing applications. In this study, we investigate the interaction between ZIF-based MOFs and lysozyme to understand the binding mechanism and its influence on protein structure. ZIF-8 and ZIF-67 nanoparticles were synthesized via a facile room temperature method and characterized using XRD, SEM, TEM, FTIR, DLS confirming their crystalline structure and morphology. The average particle size was determined to be 75 nm for ZIF-8 and 155 nm for ZIF-67. Protein–MOF interactions were studied using fluorescence spectroscopy, UV–Visible, circular dichroism, time resolved fluorescence spectroscopy. Fluorescence quenching analysis revealed a decrease in emission intensity of lysozyme upon the addition of ZIF-8 and ZIF-67 nanoparticles. The Stern–Volmer quenching constants (Ksv)were calculated to be 0.8×10^3 M^{-1} for ZIF-8 and 0.92×10^3 M^{-1} for ZIF-67, indicating static quenching behaviour. Binding constants (Kb) and the number of binding sites (n) were estimated to be 1.122×10^3 M^{-1} and 1.06 respectively for ZIF-8, 5.495×10^3 M^{-1} and 1.24 respectively for ZIF-67. Circular dichroism results suggested decrease in α-helix content indicating partial conformational change in protein upon interaction. Molecular docking analysis was consistent with the experimental findings, yielding docking scores of −92.09 for ZIF-8 and −95.75 for ZIF-67. These findings provide insight into the molecular interactions between MOFs and proteins and highlight the potential of ZIF-based nanomaterials for applications in drug delivery, biosensing, biocatalysis and biological diagnostics.

Keywords : ZIF-8, ZIF-67, MOFs, nanoparticle-protein interactions, lysozyme, fluorescence spectroscopy, molecular docking

Synergistic Co Delivery of Simvastatin and Curcumin Via Sprayable in Situ Hydrogel for Burn Management: Conceptual Framework

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Abstract

Burn wound healing is a complex biological process characterized by excessive inflammation, oxidative stress, impaired angiogenesis, and delayed tissue regeneration. Conventional topical therapies often face challenges associated with poor wound coverage, limited residence time, repeated application, and inadequate control of drug availability at the wound site. Therefore, an advanced localized delivery system capable of providing sustained and multifunctional therapeutic action may offer significant advantages in burn wound management. The present work proposes a novel in-situ sprayable hydrogel co-delivery system of simvastatin and curcumin designed to address multiple pathological events involved in burn wound healing. Simvastatin has therapeutic potential in promoting angiogenesis and tissue repair, whereas curcumin exhibits potent anti-inflammatory and antioxidant activities. Their complementary pharmacological actions provide a rational basis for their simultaneous delivery through a single localized platform.

The sprayable hydrogel is designed to enable uniform, non-contact application over irregular burn wound surfaces, followed by in-situ gel formation to improve wound coverage, retention, and sustained drug availability. The proposed formulation will be systematically developed and optimized to achieve desirable sprayability, gelation behavior, rheological properties, wound adhesion, drug incorporation, and controlled release characteristics. Comprehensive characterization will include physicochemical properties, drug–excipient compatibility, drug content, rheological behavior, spray performance, gelation characteristics, in-vitro drug release, and subsequent evaluation of wound-healing potential. The proposed platform is anticipated to integrate co-delivery, sustained local therapy, and in-situ wound coverage within a single sprayable system, potentially enabling simultaneous modulation of inflammation, oxidative stress, angiogenesis, and tissue regeneration. This multifunctional strategy may provide a promising alternative to conventional topical approaches and establish a novel formulation platform for localized and effective burn wound management.

Keywords: Burn wound healing, Sprayable in-situ hydrogel, Simvastatin, Curcumin, Co-delivery system, Angiogenesis, Anti-inflammatory.

Sialylation-driven Membrane Remodeling Governs Cellular Uptake Of Dna Tetrahedral Nanocages: Implications For Cancer-targeted Nanotherapeutics.

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Abstract

DNA nanocages, a class of precisely engineered nucleic acid biomaterials with defined geometry and intrinsic surface electronegativity, represent a promising class of anionic nanomaterials for targeted drug delivery and cancer therapy, yet their efficient cellular internalization, despite electrostatic repulsion by the anionic cell membrane, remains paradoxical. Interestingly, cancer cells, which exhibit an elevated negative surface charge due to overexpression of sialic acids, show markedly higher uptake of these nanostructures than normal cells, highlighting a critical gap in mechanistic understanding. Using chemical modification of cell-surface sialylation in non-cancerous RPE1 cells to generate three distinct bio-interface sialylation states, combined with inhibitor-based dissection of endocytic pathways, we demonstrate that elevated sialylation governs DNA nanocage uptake not through electrostatics but by structurally remodeling the cell surface, specifically through sialylation-driven expansion of GM1-enriched lipid raft microdomains, which recruits lipid raft-mediated endocytosis as a concurrent internalization route alongside clathrin-mediated endocytosis. These findings establish the tumor glycocalyx as a dynamic, cancer-selective biointerface whose sialylation state encodes both the magnitude and the mechanistic identity of biomaterial internalization. This identifies tumor glycocalyx as an exploitable parameter for the rational design of nucleic acid biomaterials for cancer-targeted delivery.

Keywords: DNA nanocages, Sialylation, Bio-interface, Lipid-raft, Clathrin mediated endocytosis.

Synthesis and Multimodal Physicochemical Characterization of Manikya Bhasma (Ruby Nanoparticles) :Structural, Elemental, and Thermal Profiling

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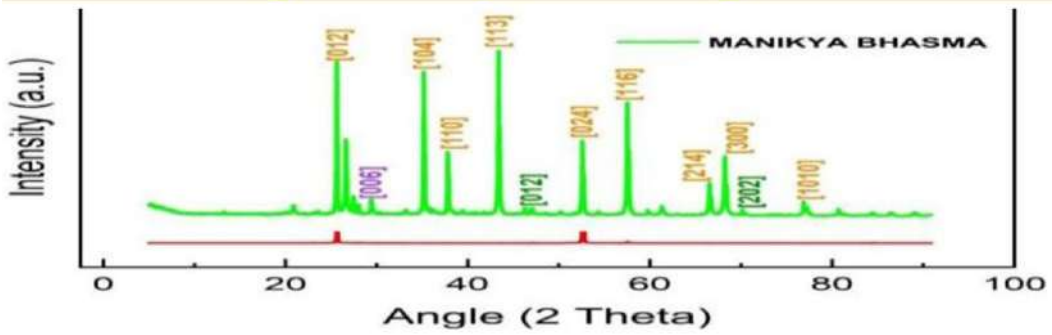
Abstract

Traditional Indian pharmaceutical systems have long employed calcination-based processing to convert bulk metal and mineral substrates into fine particulate therapeutic formulations, classically termed Bhasma. Among these, gemstone-derived preparations remain a relatively underexplored subclass with respect to modern physicochemical characterization and translational validation. Manikya (Ruby), a corundum-based crystalline aluminium oxide (α-Al O) mineral, has been used as a digestive stimulant, aphrodisiac, cardioprotective, and cognitive-enhancing agent in traditional medicine. The present study aimed to synthesize ruby-derived nanoparticles through a classical thermal processing method and characterize their crystallographic, morphological, elemental, and thermal properties using standard nanomaterial analytical techniques.

Materials and Methods: Raw Manikya (Ruby) ore was subjected to repeated thermal cycling (100 cycles of heating and rapid quenching) in an aqueous rose hydrosol (Rosa centifolia L. distillate), followed by 11 cycles of wet-milling and calcination. The synthesized nanoparticulate Manikya Bhasma was characterized using XRD for crystallographic phase identification, DLS for hydrodynamic particle size distribution, FTIR for functional group analysis, FE-SEM for surface morphology, and BET analysis for specific surface area and pore-size distribution, along with ICP-OES and EDAX/EDS for elemental profiling. Thermal stability and phase-transition behavior were evaluated via TGA, DTA and DSC.

Results: The synthesized nanoparticles met standard pharmaceutical quality-control benchmarks, with pH 7.8, total ash content of 99.62%, and acid-insoluble ash of 96.82%.
XRD confirmed retention of the α-Al O (corundum) crystal lattice, with emergence of minor secondary calcium-based phases and a measurable reduction in crystallite size, consistent with nanostructural transformation during processing.

Fig 1: X-Ray Diffractogram



DLS analysis demonstrated significant particle-size reduction to the sub-micron range (400–500 nm), while BET analysis confirmed a mesoporous surface architecture.

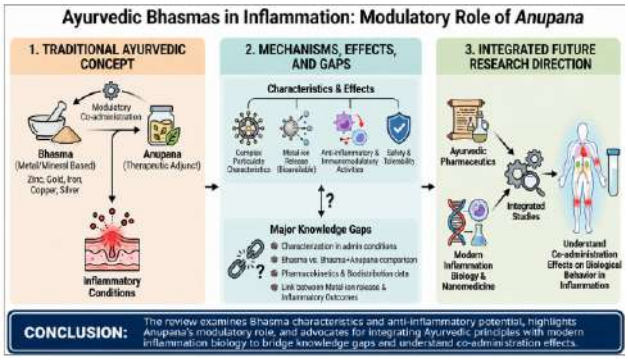
Ayurvedic Bhasmas in Inflammation: Exploring the Modulatory Role of Anupana as a Traditional Therapeutic Adjunct

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Abstract

Ayurvedic Bhasmas are traditionally prepared metal and mineral based formulations with various therapeutic applications. Various physicochemical studies have demonstrated that Bhasmas exhibit complex particulate characteristics, diverse elemental compositions and the ability to release biologically available metal ions. Their function in inflammatory diseases has yet to be fully integrated with the current knowledge on metal homeostasis, oxidative stress and immune regulation. Moreover, the use of a traditional therapeutic adjunct (Anupana) to enhance or alter the effect of Bhasma has been minimally systematically studied and a specific therapeutic effect of the adjunct remains largely unexplored in the context of inflammatory responses associated with Bhasma.



Physicochemical characteristics, metal-ion release, anti-inflammatory and immunomodulatory activities and safety of the major Ayurvedic Bhasmas are critically reviewed, focusing on different Bhasmas like zinc, gold, iron, copper and silver Bhasmas. It also addresses the potential for modulation by Anupana of dissolution, bioavailability, tissue exposure, therapeutic effect and tolerability and identifies the difference between direct evidence and mechanistic inferences. The mechanism is provided by a brief introduction into the modern literature on metal-ion biology and inflammatory signalling, which does not imply a similarity between traditional Bhasmas and engineered nanoparticles.

The review highlights several critical knowledge gaps including inadequate characterization of Bhasmas under actual administration conditions, limited comparative evaluation of Bhasma alone versus Bhasma administered with Anupana, insufficient pharmacokinetic and biodistribution data, and limited understanding of the relationship between metal-ion release and inflammatory outcomes. A research direction is suggested to be followed with a focus component in the future, where Ayurvedic pharmaceutics are combined with the latest inflammation biology and nanomedicine. These studies could help understand the significance of co-administration's effect on biological behavior of Bhasmas during systemic inflammatory stresses.

Keywords: Ayurvedic Bhasma; Anupana; Inflammation; Metal Homeostasis; Oxidative Stress; Immunomodulation; Nanomedicine

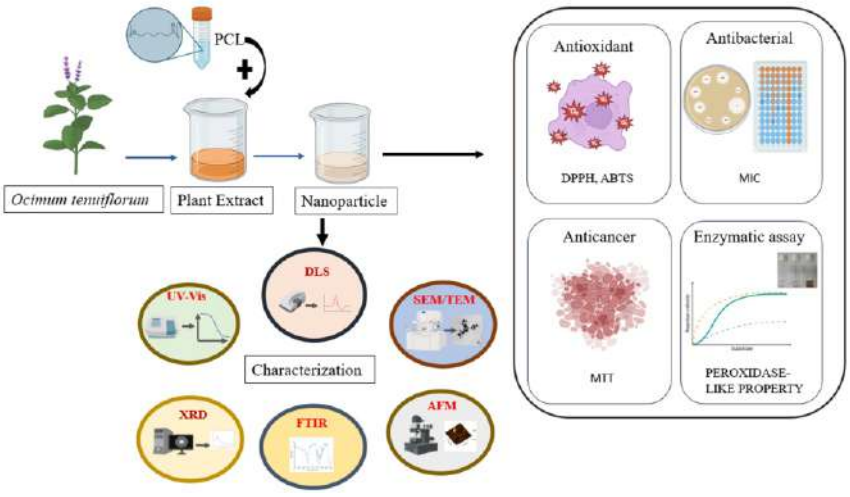
Synthesis, Characterization, And Multifunctional Properties Of Biogenic Polymeric Nanozyme

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Abstract

Green synthesis of biodegradable polymeric nanoparticles using plant-derived phytochemicals offers a sustainable alternative to traditional chemical surfactant-based synthesis. Despite increasing interest in green polymeric nanoparticles, reports integrating detailed physicochemical characterization with enzyme-mimetic activity and multiple biological functionalities remain scarce. In this study, poly(ε-caprolactone) nanoparticles (PCL-NPs) were synthesized via the nanoprecipitation method using Ocimum tenuiflorum aqueous leaf extract as a natural surfactant and stabilizing agent, thereby eliminating the need for synthetic surfactants. The synthesized PE-PCL-NPs were spherical (30–90 nm), moderately monodisperse (PDI 0.304), and displayed moderate colloidal stability (zeta potential −14.8 mV). Physicochemical characterization confirmed the formation of semi-crystalline polymeric nanoparticles with phytochemical surface functionalization. PE-PCL-NPs exhibited intrinsic peroxidase-like nanozyme activity likely arising from phytochemical moieties used for synthesizing the nanoparticles. The catalytic activity was determined through the oxidation of o-dianisidine with hydrogen peroxide, with apparent Michaelis–Menten kinetic parameters of Km = 0.42 mM (o-dianisidine) and 12.6 mM (H O), Vmax of 18.4 µM min ¹, and specific activity of 4.8 U mg ¹ nanoparticle, demonstrating efficient enzyme mimetic catalytic behaviour. The nanoparticles also exhibited concentration-dependent antibacterial activity against Escherichia coli and Staphylococcus aureus with MIC values of 0.3125 mg/mL for both bacterial strains. In addition, PE-PCL-NPs demonstrated strong antioxidant activity, achieving 79.3% DPPH radical-scavenging activity at 2mg/mL, and induced dose-dependent cytotoxicity against MDA-MB-231 triple-negative human breast cancer cells, with an IC value of 21 µg/ mL following 72 h of treatment.



Overall, these findings revealed that O. tenuiflorum-mediated PE-PCL-NPs constitute a sustainable multifunctional polymeric nanozyme with promising catalytic, antimicrobial, antioxidant, and anticancer properties, highlighting their potential for future biomedical and therapeutic applications.

Keywords: Poly(ε-caprolactone) nanoparticles, Green synthesis, Polymeric nanozyme,Enzyme kinetics

Machine Learning Framework for the Discovery of Novel Antimicrobial Resistance Targets in Klebsiella pneumoniae

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Abstract

Antimicrobial Resistance (AMR) has emerged as a key global public health threat by decreasing the efficacy of antibiotics. While conventional phenotypic testing is reliable, it is time-consuming and expensive. With Whole Genome Sequencing (WGS), one can make resistance prediction directly based on bacterial DNA.

Machine Learning makes it possible to find genomic features that are linked to antibiotic resistance. While almost all machine learning (ML) models are able to correctly classify a bacterial strain as susceptible or resistant, they cannot infer the mechanism behind the resistance. Such a conventional approach to classification does not allow us to discover new drug targets. Our work introduces a methodology for discovering such targets through prediction model

We have created an end-to-end computational pipeline based on 5,356 experimentally verified K. pneumoniae genome sequences from the BV BRC database. The ML models were used to predict Minimum Inhibitory Concentrations (MIC) of 3 popular antibiotics – Meropenem, Ciprofloxacin and Colistin. The pipeline started with sparse hashing of 11-mer genomic features where the key focus was made on feature engineering: We constructed a lineage-aware matrix containing both epistatic and other features since we understand that there is a multi-genomic basis of bacteria antibiotic resistance, and we performed subtractive genomics. To predict MICs, we used stacking ensemble regression and physical down sampling since the data is imbalanced. To differentiate between stealthy resistance drivers and housekeeping genes, we have used SHAP analysis combined with the Very Major Error (VME) exclusivity score.

Results: The ensemble regressors obtained EA of 69.73% for ciprofloxacin with Precision: 0.8794 and PR-AUC: 0.9752, 59.21% for colistin with Precision: 0.3501 and PR-AUC: 0.3923, and 45.07% for meropenem with Precision: 0.5591 and PR-AUC: 0.6917. To move from mathematical prediction to actual biological targets, the top-ranked 11-mers were pinpointed by selecting 211 bp spatial anchors, followed by rigorous FASTA deduplication in order to avoid ambiguous mapping while preserving strain-specific variability. We were able to successfully validate known mobile genetic elements (such as IS3/IS903 transposases) and LysR family transcriptional regulators using subtractive genomic alignment to the complete reference genome sequence of K. pneumoniae HS11286 (GCF_000240185.1). Thus, the next step is to perform additional analysis and select targets to proceed with the de novo drug development pipeline. Our approach shows that combining analysis of model failures with subtractive genomic alignments gives a powerful dry-lab approach to target identification. Using computational translation of mathematical k-mer properties into novel biological loci gives us valuable candidates for further structural modeling and in vitro drug screening.

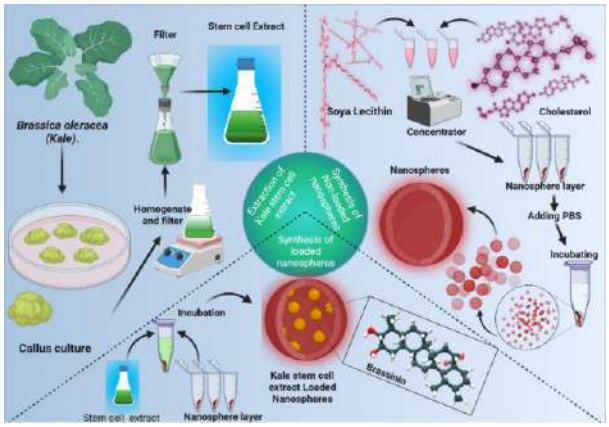
Brassica Oleracea (kale) Nanosphere For The Remediation Of Skin Hyperpigmentation- A Novel Approach With Stem Cell Extracts

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Abstract

Skin hyperpigmentation is a prevalent dermatological concern characterized by excessive melanin production and uneven distribution of pigment within the epidermis. Although several depigmenting agents are currently available, their long-term use may be limited by irritation, instability, poor skin penetration, and cytotoxicity, highlighting the need for safer and more sustainable therapeutic alternatives. Brassica oleracea var. sabellica (kale) is a nutrient-rich botanical source containing polyphenols, flavonoids, vitamins, glucosinolates, and other antioxidant phytoconstituents with potential relevance to melanogenesis regulation and skin protection. The present study proposes the development of lecithin-based nanospheres encapsulating kale-derived plant stem cell extracts as a novel topical strategy for the management of skin hyperpigmentation. Kale explants were cultured on Murashige and Skoog medium supplemented with suitable plant growth regulators to induce callus formation. Regenerated calli were subsequently be transferred to liquid medium to establish cell-suspension cultures, followed by controlled disruption, enzymatic digestion, and filtration to obtain bioactive stem cell extracts. Lecithin-based nanospheres were synthesized using a modified emulsion-based technique and characterized for particle size, morphology, surface charge, stability, encapsulation efficiency, and release behaviour. Kale stem cell extracts were then incorporated into the nanospheres and evaluated using relevant skin-cell culture models for cytocompatibility, antioxidant activity, intracellular reactive oxygen species generation, melanogenesis, melanin content, and tyrosinase-associated responses. The optimized nanoformulation is envisioned for incorporation into a topical serum containing complementary skin-supportive components such as niacinamide, vitamin C, and hyaluronic acid.



By integrating plant stem cell biotechnology with nanocarrier-assisted dermal delivery, this approach aims to enhance the stability, bioavailability, skin interaction, and controlled delivery of kale-derived phytoconstituents. The proposed platform represents a sustainable and potentially safer strategy for developing next-generation
cosmeceutical and dermatological formulations targeting hyperpigmentation and associated oxidative stress.

Keywords: Hyperpigmentation, Nanosphere, Stem cell, Kale.

Reversing Chemoresistance: A Smart Thermoresponsive Gel For Localized Co-delivery Of Salinomycin And Oxaliplatin In Metastatic Gastric Cancer

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Abstract

Objectives: Gastric cancer associated with peritoneal metastasis tends to relapse due to chemoresistance and presence of CSCs. Salinomycin can effectively target CSCs and inhibit the EMT mediated drug resistance while oxaliplatin acts as an effective cytotoxic agent that destroys the majority of tumor cells. Therefore, in the current research, a locally acting thermoresponsive system was designed using an customized Reverse Pluronic (RP) polymer, that is, a PPG rich triblock, which contains ionizable tertiary amine head groups, for salinomycin and oxaliplatin co-delivery.

Methods : The RP polymer readily formed a depot system consisting of thermoresponsive micelles and gels at 37°C for intraperitoneal delivery. The salinomycin and oxaliplatin were loaded within the hydrophobic core of PPG block and ionizable amine group, respectively. Therefore, the delivery system could achieve a pH sensitive and sustained release profile with minimal systemic release. With regards to SGC 7901 and MKN 45 cells, it showed good drug loading capacity, as well as high cytotoxicity, which caused higher cell apoptosis.

Results: Compared to single agents, a more significant decrease of CSCs (CD44) as well as EMT markers expression was observed. In an peritoneal-metastasis gastric-cancer model, injecting the RP-based thermoresponsive depot directly into the peritoneal cavity significantly decreased tumor burden and improved survival over systemic oxaliplatin or simple free-drug combinations. The local depot also reduced tumor-associated fibrosis and CSC-rich niches, pointing to a favorable modulation of the peritoneal tumor microenvironment.

Conclusions: The present work introduces a novel RP-based ionizable-head polymer that integrates thermoresponsive gelation and co-delivery of salinomycin and oxaliplatin as a unified platform for gastric-cancer-peritoneal-metastasis therapy. This strategy brings together CSC-targeted therapy and bulk-tumor-cell killing in one system, potentially overcoming EMT-driven chemoresistance while minimizing systemic toxicity.

Keywords: gastric cancer; peritoneal metastasis; chemoresistance; cancer stem cells; thermoresponsive drug delivery

Eco-toxicological Effects Of Copper-associated E-waste-derived Pvc Microplastics: Oxidative Stress, Apoptosis, And Developmental Toxicity In Zebrafish Embryos

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Abstract

Electronic waste (e-waste) is an increasingly important source of plastic derived particles and toxic metals that may be simultaneously released into aquatic ecosystems. Their co-occurrence may alter contaminant bioavailability and biological effects. However, eco-toxicological studies predominantly examine pristine microplastics (MPs) and dissolved metals as isolated stressors. The physicochemical and toxicological behaviour of environmentally derived secondary MPs carrying associated metals remains poorly understood.

In the present study, polyvinyl chloride (PVC) MPs derived from discarded e-waste were used to develop an environmentally relevant particle model for investigating copper-associated hybrid contamination. Environmentally relevant exposure concentrations were selected to mimic realistic contamination scenarios. We hypothesized that Cu^{2} association would alter PVC MP properties and bioavailability, producing biological responses distinct from MPs or dissolved copper alone.

PVC MPs were obtained from e-waste derived materials and associated with $CuSO_4 \cdot 5H_2O$ under UV-assisted conditions to generate a copper-associated MPs system (MP@Cu). The materials were characterized using UV-Visible spectroscopy, dynamic light scattering, zeta potential analysis, scanning electron microscopy, and energy-dispersive X-ray spectroscopy. Comparative eco-toxicological effects of MP, Cu, and MP@Cu were evaluated in zebrafish embryos up to 72 hour post fertilization. Developmental endpoints, ROS generation using DCFDA, and apoptosis using Acridine orange were assessed using microscopy and flow cytometry. Molecular docking examined interactions with proteins involved in hatching, antioxidant defence, and cellular stress.

Copper association altered the physicochemical characteristics of e-waste-derived PVC MPs, including changes in surface charge, while elemental analysis supported copper association with the particle surface. Exposure produced concentration-dependent developmental and cellular responses. Dissolved copper produced the strongest acute toxic effects, whereas MP@Cu exhibited an intermediate but distinct toxicity profile, indicating that association with the PVC matrix modified the biological behaviour of copper. Increased ROS and apoptosis accompanied developmental impairment, implicating oxidative stress and cellular injury in toxicity. Molecular docking further suggested interactions of the exposure components with proteins involved in Hatching, antioxidant regulation, and cellular stress pathways such as Zhe1, Sod1, and p53. In summary, copper association altered the physicochemical and biological behaviour of e-waste-derived PVC MPs, generating a hybrid contaminant with distinct toxicity. These findings highlight the need to consider environmentally relevant particle-metal hybrids as distinct toxicological entities in ecological risk assessment.

Keywords: E-waste; PVC microplastics; Copper; Hybrid contaminants; Zebrafish embryos; Oxidative stress; Apoptosis.

A Novel Antimicrobial Peptide Exhibit Cell Penetrating Property In A549 Cell Line And Kills Intracellular Acinetobacter Baumannii

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Abstract

Acinetobacter baumannii is one of the critical priority pathogens listed by WHO in its bacterial priority pathogen list (2024). It contributes significantly to the hospital acquired infections in India, with approximately 86.1% of isolates showing resistance to carbapenems as reported by ICMR in 2025. Although robust antimicrobial stewardship programs are essential for reducing inappropriate antibiotic use and limiting the emergence and spread of resistance, stewardship alone is unlikely to address the growing therapeutic gap. Therefore, there is an urgent need to develop novel antimicrobial strategies with activity against multidrug-resistant pathogens. Antimicrobial peptides (AMPs) represent a promising class of alternative therapeutics due to their broad-spectrum antimicrobial activity, diverse mechanisms of action, and potential to reduce the likelihood of conventional resistance development.

CDAP-2 is a novel membrane-active peptide showing broad-spectrum antibacterial activity. It has a minimum inhibitory concentration (MIC) of 5 μM against carbapenem resistant Acinetobacter baumannii (CRAB) and works mainly by damaging the bacterial membranes. In this work, the cell penetrating property of CDAP-2 is evaluated in A549 cell lines (human lung adenocarcinoma cell line) as A. baumannii is known to cause severe pneumonia. Before beginning, the cytotoxicity of peptides was evaluated on this cell line, and it was found that CDAP-2 is non-toxic at working concentrations. Moreover, it shows cell penetration and internalization starting from 2.5 μM as investigated using flow cytometry. Peptide uptake in presence of various endocytic inhibitors indicates that the peptide uptake happens primarily in an energy dependent manner. Confocal microscopy shows that in some cells CDAP-2 was also found to localize with acidic organelles (lysosomes) while majority of peptide molecules were present randomly thought the cell except the nuclear region. This peptide also has cargo delivery ability as evident by functional delivery of β-galactosidase in A549 cell line.

After evaluation of cell penetrating activity, the effect of peptide was evaluated on killing the intracellular bacteria in A549 cells as certain clinical strains can invade and persist in epithelial cells. The peptide significantly reduced the bacterial load in a concentration-dependent manner, as demonstrated by the enumeration of bacterial colony-forming units (CFUs) recovered from each well of the assay plate.

Keywords: Antimicrobial peptides, Nanotherapeutics, Acinetobacter, Antimicrobial resistance, Drug Discovery and Development, Intracellular infection

Oral Delivery Of A Bio-inspired Ionic Liquid-based Formulation For Effective Breast Cancer Therapy

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Abstract

Breast cancer remains a major global health burden, while the poor aqueous solubility and limited oral bioavailability of several anticancer agents continue to restrict their therapeutic effectiveness. Quercetin has poor aqueous solubility, undergoes extensive gastrointestinal metabolism, and has limited oral bioavailability. The present work aims to develop a bio-inspired ionic liquid-based oral delivery platform to overcome these biopharmaceutical limitations and enhance the therapeutic potential of these poorly soluble anticancer agents. A cholinium-based ionic liquid containing an amino acid-derived counterion was explored as a biocompatible formulation platform. Quality by Design-guided formulation development and optimization was successfully done. For quercetin, successful formulation development resulted in an aqueous-soluble system with a marked improvement in apparent solubility, increasing from 0.0025 mg/mL for free quercetin to 50 mg/mL in the ionic liquid formulation. The optimized formulation exhibited a pH of 7.3, viscosity of 445.67 mPa.s, and water content of 4.51%. Comparative in-vitro release studies indicated enhanced quercetin release from the ionic liquid formulation under simulated gastrointestinal conditions. Validated UHPLC and LC-MS/MS methods were also developed for quantitative estimation and subsequent bioanalytical investigations of quercetin, and all the validation data were found to be within the limits as per ICH guidelines. The reduction in IC_{50} from 2 µM for free quercetin to 0.5 µM for the ionic liquid-based formulation in MDA-MB-231 cells has been observed. Overall, the findings support the potential of bio-inspired ionic liquids as a scalable oral delivery platform for poorly soluble anticancer drugs.

Keywords: Bio-inspired ionic liquids; Quercetin; Oral drug delivery; Poorly water-soluble drugs; Breast cancer; Bioavailability.

Soil–Plant–Nanoparticle–Human Health Continuum: Fate, Transformation and Implications of Nanomaterials in Agricultural Soils

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Abstract

The rapid expansion of nanotechnology in agriculture has increased the intentional and inadvertent introduction of engineered nanomaterials into agricultural soils, creating an emerging environmental interface between soil processes, plant health, food safety, and human health. Although considerable research has examined the agronomic benefits and individual toxicological effects of nanoparticles, their behaviour across the interconnected soil–plant–human continuum remains insufficiently resolved. Agricultural soils are dynamic biogeochemical environments in which nanoparticles undergo adsorption, aggregation, dissolution, redox transformation, and interactions with soil minerals, organic matter, and microorganisms. These processes can substantially modify their mobility, persistence, bioavailability, and subsequent transfer to crops. This perspective proposes an integrated Soil–Plant–Nanoparticle–Human Health Continuum to bridge the current knowledge gap between environmental nanoscience and human health. Particular attention is given to the role of soil organic carbon, clay minerals, pH, cation exchange capacity, redox conditions, and microbial activity in regulating nanoparticle fate and transformation. Changes in nanoparticle physicochemical properties may influence soil microbial functioning, nutrient cycling, root interactions, plant uptake, translocation, and accumulation in edible tissues, potentially establishing previously underappreciated pathways of human dietary exposure. At the biological interface, nanoparticle interactions with human cells may involve oxidative stress, membrane perturbation, inflammatory responses, and other mechanisms that warrant systematic assessment. The proposed framework emphasizes that nanoparticle risk cannot be adequately understood through isolated soil or toxicity studies. Instead, soil physicochemical properties, microbial indicators, nanoparticle characteristics, plant uptake, food-chain transfer, and human exposure should be evaluated as interconnected components of microbial biomass carbon and soil biochemical attributes as early indicators of nanoparticle-induced ecological stress and in determining how different soil carbon pools regulate nanoparticle bioavailability. Integrating advanced nanomaterial characterization, soil science, plant physiology, microbiology, exposure assessment, and toxicological approaches could establish a more predictive basis for evaluating nanomaterial behaviour and risk. Such a systems-level perspective can contribute to the responsible advancement of agricultural nanotechnology while simultaneously protecting soil health, food safety, environmental quality, and human well-being.

Keywords: Nanoparticles; Agricultural soils; Soil–plant continuum; Nanomaterial fate; Human health.

Evaluation of composition and antioxidant potential of rhizome essential oil of Curcuma caesia Roxb.

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Abstract

Black turmeric (Curcuma caesia Roxb.) with bluish-black rhizome, is an important medicinal plant of family Zingiberaceae family. The rhizome as well as the leaves of this plant have been used in ethnomedicinal practises since time immemorial. The various pharmacological activities of this plant includes antimicrobial and anti-oxidant anti-inflammation, anti-cancer, hepato protective, diuretic, antiasthma activities, antifungal activity, smooth muscle relaxant, analgesic activity, locomotor depressant, anticonvulsant and muscle relaxant effects, anxiolytic and CNS depressant activity, anti bacterial activity, anti ulcer activity and many other activities. The major phytochemicals present in the rhizome of this plant are α-Santalol (46.90%), Retinal (10.72%), Ar-tumerone(10.38%), Alloaromadendrene (5.93%), Megastigma-3,7(E),9-triene (4.80%), Benzene, 1-(1,5-dimethyl-4-hexenyl)- 4-methyl(4.38%), 5,8,11,14,17-Eicosapentaenoic acid, methyl ester, (all-Z)- (4.26%) Tricyclo [8.6.0.0(2, 9)] hexadeca-3,15-diene, trans-2,9-anti-9,10- trans-1,10(3.26%) and various other compounds.

North East India is rich in biodiversity of black turmeric. Total 17 accessions were collected from Arunachal Pradesh, Mizoram, Meghalaya, Nagaland, Manipur, Assam, Tripura and ICAR- RCNEH Region. Essential oil was extracted from fresh rhizomes by hydrodistillation using a Clevenger apparatus. Characterized through gas chromatography–mass spectrometry (GC–MS). The antioxidant potential of the oils was evaluated using DPPH and ABTS radical scavenging assays.

Essential oil yield% (v/v) of 17 accessions were ranges from 0.18% to 0.67%. TR-1 accession produced the highest yield while MEG-2 yield the lowest essential oil. GC-MS analysis of essential oil identified 58 compounds. Epicurzerenone is found to be the predominant constituent of the rhizome essential oil, with accession MZ-2 recording the highest relative abundance of this compound. NG-1 demonstrated the strongest antioxidant activity in both DPPH and ABTS assays. These elite accessions represent valuable resources for conservation, crop improvement, bioprospecting, and future pharmaceutical, nutraceutical and aromatic applications.

Keywords: Black turmeric, rhizome, essential oils, terpenoids, antioxidant activity.

Fluconazole-loaded Nanosponges For Enhanced Topical Delivery in Cutaneous Leishmaniasis: Formulation, Optimization, and In Vitro Evaluation

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Abstract

Cutaneous leishmaniasis (CL) is a neglected vector-borne disease causing disfiguring skin lesions, with current therapies limited by systemic toxicity, poor skin penetration, and emerging drug resistance. Fluconazole, a BCS Class I antifungal with recognized anti-leishmanial activity, suffers from inadequate topical bioavailability. This study aimed to design, optimize, and evaluate fluconazole-loaded nanosponges for enhanced topical delivery against CL. Nanosponges were fabricated using the emulsion-solvent diffusion method with HPMC and PVA as polymers. A Box-Behnken design optimized three critical factors: HPMC concentration (0.5–0.8 g), PVA concentration (0.5–1.0 g), and stirring speed (1500–2500 rpm). Formulations were characterized for entrapment efficiency (EE%), drug loading, particle size, zeta potential, surface morphology (SEM), in vitro drug release, and antifungal activity against Aspergillus niger. The optimized formulation (F5: 0.8 g HPMC, 1.0 g PVA, 2250 rpm) achieved 99.52% EE, a particle size of 377.3 nm, and a zeta potential of -24.6 mV. In vitro release studies using Franz diffusion cell demonstrated only 0.537% drug release over 10 hours, indicating excellent sustained release (R^2 = 0.9904, near zero-order kinetics). Antifungal studies confirmed retained bioactivity with a mean inhibition zone of 1.875 cm against A. niger, confirming that encapsulation does not degrade fluconazole. This is the first study to report fluconazole-loaded nanosponges specifically for cutaneous leishmaniasis. The formulation offers a safe, sustained-release topical platform that overcomes the limitations of conventional CL therapies, including poor skin penetration, systemic toxicity, and frequent dosing. Future work includes cell line studies and in vivo evaluation of chitosan-coated fluconazole nanosponges.

Keywords: Cutaneous leishmaniasis, fluconazole, nanosponges, Box-Behnken design

Tear Restoring Nanoplex: An Arginine-crosslinked Hyaluronic Acid Delivering Dexamethasone With Enhanced Mucoadhesion and Corneal Retention

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Abstract

To develop and characterize dexamethasone loaded hyaluronic acid nanoparticles ionically crosslinked with L-arginine (ADHA NPs) for ocular surface retention and tear function recovery in a rabbit model of dry eye syndrome.

Methods: DHA-NPs were prepared by ionic gelation method utilizing arginine as cationic crosslinker. In this study, a Box Behnhenk design was employed to optimize different process variables, i.e., concentrations of polymer (PCL), crosslinker (Arg), and stirring time. Particle size and % Entrapment Efficiency were selected as critical quality attributes. Characterization of NPs were carried out by DLS, SEM, drug–excipient compatibility studies by FTIR, DSC and XRD. Molecular modeling studies including in silico docking studies were performed to know the interaction (binding affinity) of Arg, DEX with IL-1β and TNF-α. The NPs were subjected to in vivo studies including ocular irritation study (Draize test), basal and stimulated tear production (Schirmer test), tear quality (ferning test) and corneal adhesion study in benzalkonium chloride induced rabbit dry eye model.

Results: ADHA NPs presented a suitable platform for the sustained ocular delivery of less water-soluble dexamethasone. The optimized ADHA NPs had average diameter of 198.1 ± 1.74 nm (PDI 0.131) with improved solubility (approximately 2.5 fold) and 89.33 ± 1.92% entrapment efficiency. Long term sustained drug release profile (94.99 ± 4.16% in 6 h) followed Korsmeyer-Peppas release kinetics (R^2 = 0.9811). These NPs demonstrated excellent moisture adsorption capacity (86.89 ± 1.41%) along with concentration dependent mucoadhesive property. The molecular docking study indicated approximately 6.7 fold higher binding affinity of arginine with proinflammatory cytokines IL 1β (−6.731 kcal/mol) and TNF α (−4.601 kcal/mol) as compared to dexamethasone. In vivo evaluation revealed more than two-fold enhanced tear production up to 5 days along with normal tear ferning pattern and negligible ocular irritation (Draize score 0–1) and ADHA NPs remained stuck on corneal surface up to 12 h.

Conclusion: Arginine crosslinked hyaluronic acid nanoparticles were utilized as sustained delivery system for dexamethasone eye drops to treat dry eye syndrome based on mucoadhesion and enhanced tear volume and corneal retention.

Keywords: Hyaluronic Acid, Arginine, Dry Eye Syndrome, Qbd, Dexamethasone

Physicochemical characterization of underutilized starch from Curcuma angustifolia Roxb.

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Abstract

Curcuma angustifolia is commonly known as East Indian arrowroot. It belongs to the family Zingiberaceae and is found copiously in the Central, Southern and in the North eastern region of India. It is a rhizomatous perennial flowering plant. The plant is well known for its use in ethnomedicine as demulcent, antipyretic and blood coagulant. Leaf oil of C. angustifolia possesses antibacterial and antifungal properties. The phytopharmacological profiling of C. angustifolia reported the presence of alkaloids, flavonoids, terpenes, carbohydrates and total phenolics. It was also reported that the rhizome essential oil contains A &B -pinenes, (-) arcurcumene, Zingiberol, (+) camphor (+) x- terpineol, (+) borheol, Zingiberol and many other mono and sesquiterpenoids. The GC-MS analysis of leaf essential oil reported the presence of Curzerenone (33.2%), 14-hydroxy-δ-cadinene (18.6%) and γ-eudesmol acetate (7.3%) where the rhizome essential oil contains curzerenone (72.6%), camphor (3.3%) and germacrone (3.3%) as major terpenoids. According to another study report, the GCMS analysis of rhizome methanolic extract showed the presence of oleic acid (23.5%), n-hexadecanoic acid (16.67%), nitrous oxide (12.31%), acetic acid (6.01%), octadecanoic acid (5.55%), 2-propanone 1-hydroxy (4.85%), gama sitosterol(2.64%), (+)-2-bornanone (2.53%), 5- hydroxymethylfurfural (2.31%), 4,7-methanofuro[3,2-c]oxacycloundecin-6 (2.03%), naphthol [2,3-b]furan-2(3H)- one, 4-(acetyloxy (1.49%), 1-heneicosanol (1.44%), isoborneol (1.44%), borneol (1.38%), propanoic acid, 2-oxo-, methyl ester (1.31%), eucalyptol (1.04%).

Both leaves and rhizome of C. angustifolia have been reported to have a camphoraceous aroma and comprises diverse functional constituents such as phenolics, flavonoids and various antioxidant enzymes. It has also been reported that the major constituent of tikhur is starch (97.43%) and it is low in fat (2.72%) and protein (0.62%) and ash content. Tikhur starch consists of 32.30% amylose and 67.70% amylopectin. Its starch granules are polyhedral, with a diameter of 9.75 to 20.43 µm and 3.409 to 5.272 µm in width. Its starch clarity and solubility are comparable with those of corn and cassava starch. Its starch display higher pasting temperature (76.25 °C), suggesting the tendency to form faster paste and stability under high cooking conditions. With an outstanding physio-chemical property C. angustifolia offers an outstanding source of inspiration for the development of high-performance-value-added biomaterials.

Keywords: East Indian Arrowroot, Curcuma angustifolia, physio-chemical properties

Ethnobotanical documentation of medicinal and aromatic plants used in Mizo traditional concoctions

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Abstract

The Mizo people are a Tibeto-Burmese ethnic group who are native to the state Mizoram of India and neighbouring regions of North East. The Mizo are divided into many clans like Ralte, Paite, Lai, Hmar, Lusei, Mara and Thadou/Kuki. These clans have their own separate method of treating ailments by preparing concoctions. The traditional concoctions are mainly developed from medicinal and aromatic plants having health benefits or with a stimulatory potential used for pleasure and recreation. Several traditional concoctions particularly Bai and Tlak are consumed by the ethnic societies in Mizoram. Bai is the process of boiling the herbs in water along with adding salt and cooking soda (Ash filtrate) while Tlak is simply boiling the herbs in water. Some of the plants used in Bai and Tlak are Khanghu (Acacia pennata), Baibing (Alocasia fornicata), Phuihnam (Clerodendrum colebrookianum), Thingthupui (Dysoxylum gobara), Bahkhawr (Eryngium foetidum), Anthur (Hibiscus sabdariffa), Anhling (Solanum nigrum), Chingit (Zanthoxylum rhetsa),There is no proper documentation of the importance and use of these plants as traditional concoctions and the knowledge have been imparted only orally so if there is a proper scientific validation of the health benefits then it will lead to the acceptance beyond the local boundaries for wider application and exploring their commercialization potential.

Key words: Mizo, concoctions, health benefits, Bai and Tlak, scientific validation

Novel Drug Delivery Systems Based on Herbal Formulations

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Abstract

Herbal medicines occupy a central place in traditional healthcare, yet many plant-derived actives suffer from poor aqueous solubility, large molecular size, extensive first-pass metabolism, and instability in the gastrointestinal environment, which together limit their absorption and clinical bioavailability. A recurring limitation is that the active phytoconstituents in a conventional extract are frequently large, poorly water-soluble, or susceptible to enzymatic and acid degradation before reaching systemic circulation. A delivery carrier that is fit for purpose should ideally release the active at a rate matched to the body's needs over the treatment period and direct it preferentially toward its site of action rather than being distributed indiscriminately.

Novel drug delivery systems (NDDS) — including liposomes, ethosomes, phytosomes, polymeric nanoparticles, solid lipid nanoparticles, and nanoemulsions — have therefore been investigated as carriers for herbal actives. Reformulating a standardised extract into a nanoscale or vesicular carrier is reported to offer enhanced aqueous solubility, protection of labile constituents from degradation, improved membrane permeability with raised oral bioavailability, sustained or controlled release, and more favourable distribution to target tissues.

Overall, novel drug delivery systems offer a route to overcome the intrinsic solubility, stability, and permeability limitations of many phytoconstituents, with a growing body of evidence linking carrier-based reformulation to measurable gains in bioavailability and pharmacological activity. Continued work on extract standardisation, carrier scale-up, and long-term stability and safety characterisation will be important for translating these laboratory-stage systems into reliable, quality-controlled herbal products.

Keywords: Herbal formulation, Novel drug delivery system, Phytosome, Liposome Nanoparticle , Bioavailability.

Table 1. Overview of major carrier classes, representative herbal actives, and reported benefits.

Carrier system	Basic principle	Representative actives	Reported benefit
Liposomes / Ethosomes	Phospholipid bilayer vesicles entrapping hydrophilic/lipophilic actives	Ginkgo biloba, green tea polyphenols	Improved skin permeation, sustained release
Phytosomes	Molecular complex of extract with phosphatidylcholine	Curcumin, silymarin, ginseng	Higher membrane permeability and oral absorption
Polymeric NPs / nanocapsules	Active dispersed or encapsulated in a polymer matrix or shell	Quercetin, berberine, camptothecin	Controlled/targeted release, protection from degradation
Solid lipid nanoparticles	Active dissolved/dispersed in a solid lipid matrix stabilised by surfactant	Tripterine, vinpocetine	Better physical stability and bioavailability than liposomes
Nanoemulsions / SNEDDS	Thermodynamically stable dispersion of oil, surfactant and co-surfactant	Essential oils, resveratrol	Enhanced solubility and rate of absorption

Across independent studies on several well-known phytoconstituents, reformulation into a phospholipid complex or vesicular carrier is consistently associated with higher plasma levels or absorption relative to the plain extract, as illustrated below for a small set of commonly studied actives. Values are approximate and intended to convey direction and rough magnitude only, not precise data for any single study.

From the DSD Clinic to the Nanoscale: A Translational Perspective on Precision Diagnostics and Future Therapeutics

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Abstract

Background: Disorders/Differences of Sex Development (DSD) comprise a heterogeneous group of congenital conditions involving variations in chromosomal, gonadal, hormonal and/or anatomical sex development. Their evaluation often requires integration of clinical examination, hormonal investigations, imaging and genetic testing. Despite advances in molecular diagnostics, important challenges remain, particularly in obtaining sensitive biological information from limited sample volumes, integrating multiple diagnostic parameters and developing individualized therapeutic approaches. Emerging advances in nanomedicine offer potential opportunities to address some of these unmet clinical needs.

Objective: To explore potential translational applications of nano-enabled technologies in improving precision diagnostics and identifying future therapeutic possibilities relevant to DSD.

Translational Perspective: Nano-enabled biosensors may permit highly sensitive detection of hormones and molecular biomarkers from small biological sample volumes, an important consideration in neonatal and pediatric practice. Multiplexed nanoscale platforms could potentially enable simultaneous assessment of multiple biomarkers and complement existing endocrine and molecular diagnostic pathways. Integration of nanoscale analytical technologies with genetic and clinical information may contribute to more precise biological characterization and individualized clinical assessment. Beyond diagnostics, nanotechnology-based targeted delivery systems may provide future opportunities for controlled delivery of biologically active molecules. Nanostructured biomaterials and scaffolds may also have potential relevance to regenerative and reconstructive strategies, although such applications remain exploratory in the context of DSD.

Challenges and Future Directions: These potential applications should not be interpreted as established clinical interventions in DSD. Translation from laboratory innovation to patient care will require rigorous analytical validation, reproducibility, biocompatibility and toxicity assessment, long-term safety evaluation and demonstration of meaningful clinical benefit. Ethical considerations are particularly important in children and in conditions involving sex development. Technological innovation must support, rather than replace, multidisciplinary, individualized and patient-centred care.

Conclusion: DSD represents a clinically complex field in which precision diagnostics and individualized care remain important unmet needs. Nanomedicine offers a potential translational bridge between these clinical challenges and emerging technologies, particularly through sensitive biosensing, multiplexed molecular analysis and future targeted therapeutic approaches. Collaboration between clinicians, nanoscientists, geneticists, endocrinologists, developmental biologists and bioengineers will be essential to identify biologically meaningful applications and responsibly translate promising technologies towards clinical practice.

Keywords: Disorders of Sex Development; Nanomedicine; Precision Diagnostics; Biosensors; Pediatric Surgery; Translational Research.

Development of Newer Triazole Tethered Bis-1,4- Dihydropyridine as Potent Anti-cancer Agents and Calcium Channel Blocker

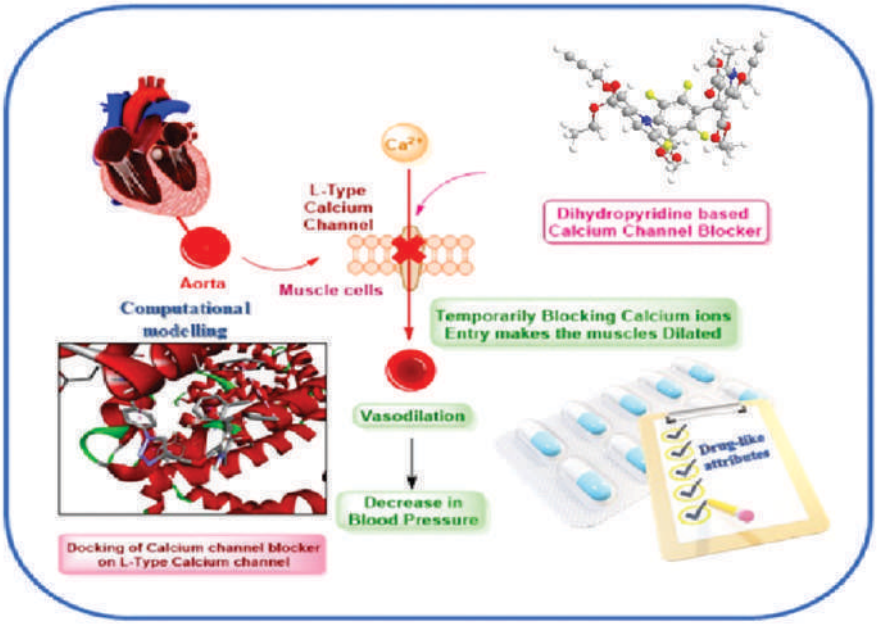
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Abstract

1,4-Dihydropyridines (1,4-DHPs) represent a notable class of heterocyclic compounds that have recently attracted significant interest for their potential anticancer properties. While they were originally known for their role as calcium channel modulators, extensive structural modifications have revealed their strong cytotoxic effects against various tumour types. These anticancer activities arise from their capacity to induce apoptosis, disrupt cell-cycle regulation, and interact with essential molecular targets such as protein kinases, tubulin, and redox-related enzymes. Advances in molecular modelling, ADMET screening, and biochemical assays have further facilitated the discovery of new 1,4-DHP derivatives with desirable drug-like characteristics. Building on these developments, a new series of bis-1,4-dihydropyridine compounds linked through a triazole moiety has been successfully designed and synthesised, achieving excellent yields and offering promising potential for further pharmacological evaluation.

Keywords: 1,4-Dihydropyridines, ADMET, Anticancer, Triazole



Anticancer Peptidic Nanomolecule Induces Membrane Disruption And Cell Death In Triple Negative Breast Cancer

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Abstract

Breast cancer is the most commonly diagnosed cancer among women worldwide, with an estimated 2.4 million new cases and 694,000 deaths in 2024. Triple-negative breast cancer (TNBC) is an aggressive and clinically heterogeneous subtype characterized by the absence of estrogen receptor, progesterone receptor, and HER2 expression. The lack of these established molecular targets limits targeted treatment options, making chemotherapy a major component of TNBC management. However, recurrence, metastasis, and the development of therapeutic resistance remain major clinical challenges. These limitations have stimulated the development of alternative strategies, including anticancer peptides (ACPs), which can be rationally designed to selectively target tumor cells and induce cell death while potentially inhibiting metastasis and angiogenesis. Membrane active Anti-cancer peptides (ACPs) have emerged as promising therapeutic agents as they selectively target negatively charged cancer cell membranes leaving normal cells unaffected. Among these, antimicrobial peptides (AMPs) are attractive templates as they have a similar affinity for negatively charged microbial membranes. A cationic AMP derived from skin secretion of Rana esculenta, displays potent membrane-disruptive activities, thus providing a promising scaffold for the development of new anticancer peptidic nanomolecules. In the present study, three peptidic analogs were designed by mutating identified amino acids to lysine and tryptophan residues to improve the electrostatic interactions and membrane insertion. Cytotoxicity and secondary structure of the parent scaffold and its analogs were evaluated. The most active analog was further investigated against the MDA-MB-231 triple-negative breast cancer cell line using clonogenic and 3D spheroid assays. Mechanistic studies of membrane disruption and underlying cell death mechanism were carried out. These results together show that the designed analog is a promising nanotherapeutic candidate for aggressive breast cancer treatment.

Keywords: TNBC, Nanomedicine, AMPs, MDA-MB-231, Membrane damage, Apoptosis, Oxidative stress

One-Pot Leuckart Amination of Graphene for Electrochemical Cancer Biomarker Immunosensing

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Abstract

The rapid and sensitive detection of cancer biomarkers is vital for early oncological diagnostics and therapeutic monitoring. However, traditional graphene functionalization often relies on hazardous, multistep processes that compromise material integrity. To address this, we present an efficient, one-pot Leuckart reaction strategy for synthesizing amine-functionalized reduced graphene oxide (NH -rGO), which serves as a transformative, label-free electrochemical immunosensing platform.

Methodology: Highly functionalized graphene oxide (GO) was derived from expanded graphite via a modified Tour's method. This precursor was subjected to a one-pot Leuckart reaction, achieving a densely populated reactive amine interface with an exceptional nitrogen content of 7.6%. To fabricate the diagnostic tool, NH -rGO was deposited onto commercial gold screen-printed electrodes (SPEs) utilizing a scalable airbrush spray technique, which circumvents the inconsistencies of traditional drop-casting. Anti-CEA antibodies were then covalently immobilized via robust EDC-NHS chemistry.

Results: The synthesized NH -rGO nanomaterial exhibited superior electrochemical properties, dramatically lowering the charge transfer resistance (Rct) to 3.58 ± 0.55 kΩ, as validated by electrochemical impedance spectroscopy (EIS). When evaluated for the detection of carcinoembryonic antigen (CEA) a critical biomarker for colorectal and lung carcinomas the platform achieved an outstanding sensitivity of 108.42 μA · decade $^{-1}$ · cm $^{-2}$. The immunosensor showcased a highly competitive Limit of Detection (LOD) of 0.00375 ng mL $^{-1}$ and a Limit of Quantification (LOQ) of 0.00598 ng mL $^{-1}$, operating across a broad linear dynamic range of 0.051 to 51.2 ng mL $^{-1}$ to cover both healthy and pathophysiological thresholds. Storage stability testing demonstrated a statistically significant current response for ~20 days, retaining 62.5% of its activity after 50 days.

Conclusion: This scalable, airbrush-spray-deposited NH -rGO platform offers a clinically translatable paradigm for next-generation, point-of-care oncological diagnostics. It not only achieves exceptional electrochemical sensitivity for CEA detection but also establishes a versatile groundwork for future antigen-based diagnostic upgrades.



Intramolecular Radical Oxidative Cyclization: Access To Fused-bicyclo[3.1.0] Hexanes From Gem-dihalo Olefins

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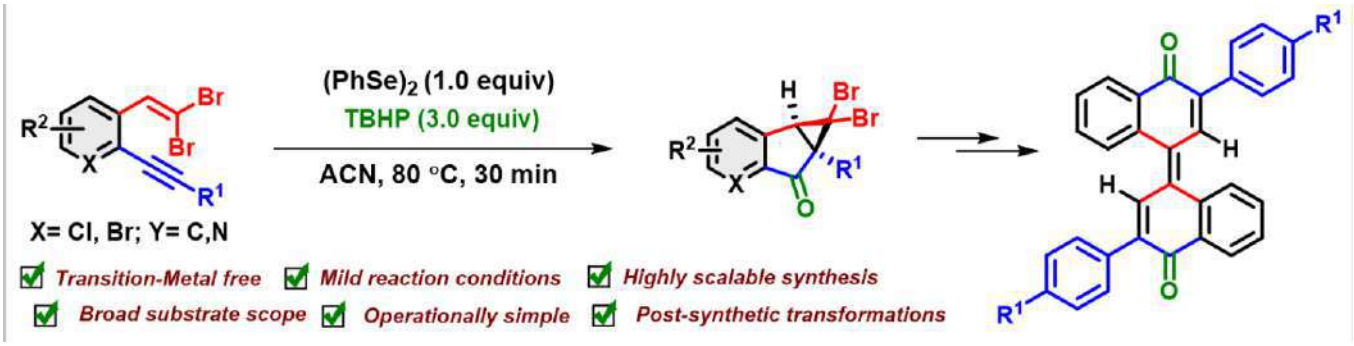
Abstract

Bicyclo[3.1.0] hexanes are valuable compounds due to their significant biological and pharmaceutical importance. Herein, we report a general transition-metal-free approach for the synthesis of benzo-fused bicyco[3.1.0] hexanes using gem-dihaloolefins. The developed protocol involves the intramolecular radical oxidative cyclization of 1-(2,2-dibromovinyl)-2-(phenylethynyl)benzenes using diphenyl diselenide and TBHP. This method avoids the need for expensive transition metal catalysts, external ligands, and prolonged reaction times. This developed protocol facilitates the formation of multiple bonds (two C-C and one C=O) in a broad range of substrates, including menthol-derived natural products. Mechanistic studies suggest that the reaction proceeds via a radical pathway.

Keywords: Gem-Dihaloolefins, TBHP, Diphenyldiselenide, Radical Oxidative Cyclization, Bicyclo[3.1.0]hexane, Dimerization

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Optimization Of Drug-lipid Solubility And Release Characteristics Of Nanostructured Lipid Carriers For Tumor-targeted Drug Delivery

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Abstract

Nanostructured lipid particles/carriers (NLPs/NLCs) have great potential as nanocarriers for tumor-targeted drug delivery due to their ability to overcome detrimental side effects and adjustable drug release profiles. The composition of the lipid matrix (solid-liquid lipid mixture), its ratio (solid-to-liquid lipid), and concentration are the principal determinants of drug encapsulation efficiency, stability, and release profile. High drug-lipid solubility is the general choice to enhance drug loading; however, extreme drug solubility/affinity for the lipid medium may hinder drug release, stressing the need to identify an ideal balance between encapsulation and release. This study aimed to evaluate drug-lipid solubility, lipid miscibility, and their release profile to establish rational criteria for lipid selection in NLC formulation. Phytochemical stigmasterol (ST) was employed as a drug model to investigate solubility in solid lipids including stearic acid (SA), glyceryl monostearate (GMS), myristic acid (MA), and beeswax (BW), and liquid lipids comprising oleic acid (OA), ethyl oleate (EO), extra virgin olive oil (EVO), vitamin E (VE), and pomegranate oil (PO). To evaluate lipid compatibility and find appropriate matrices for NLC development, binary solid-liquid lipid mixtures were made in a wide range of ratios (9:1 to 1:9, w/w). Drug solubility and lipid miscibility were evaluated using a visual screening method, such as no further dissolution of drugs characterised by the presence of persistent turbidity, cloudiness, or the presence of undissolved particles. Findings demonstrated that all the solid-liquid lipid combinations exhibited a substantially uniform distribution, with no distinct phase separation evident. For ST solubility, marked differences were observed. Amongst the solid lipids, SA exhibited the highest mean ST solubility (128.3±1.53 mg/g), followed by MA (89 ± 1 mg/g), GMS (88.3 ± 1.53 mg/g), and BW (38.3 ± 1.53 mg/g), respectively, while amongst the liquid lipids, OA exhibited the highest mean ST solubility (25±1 mg/ml), followed by EO (12 mg/ml), EVO (9.66 ± 1.15 mg/ml), PO (9.33 ± 0.58 mg/ml), and VEO (5.33 ± 0.58 mg/ml), respectively. Based on the drug (ST) solubility profile, SA and OA, exhibiting the highest drug solubilization, are identified as promising candidates for maximizing drug incorporation. However, there are reports suggesting that NLCs generated with highly solubilizing lipid mediums may exhibit slower drug release due to the strong affinity between the drug and lipid, making them less suitable for tumor targeting, which requires rapid drug release to the target tumor microenvironment. Our ongoing study evaluates NLCs loaded with ST formulated using different lipid combinations to correlate drug-lipid solubility with drug encapsulation efficiency, their physicochemical properties, and in vitro release activity. The primary objective is to determine an appropriate drug-lipid solubility threshold that balances efficient drug loading with release, thus enabling the rational design of NLCs with desired release patterns and better therapeutic efficacy for tumor-targeted drug delivery.

Keywords: Nanostructured lipid carriers, Stigmasterol, Drug solubility, Drug release.

Development of Functionalized Mesoporous Silica Nanoparticles for Efficient siRNA Delivery to Lung Alveolar Epithelial Cells: A Promising Nanomedicine Approach for Pulmonary Fibrosis

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Abstract

Pulmonary fibrosis is a progressive and fatal interstitial lung disease with excessive extracellular matrix deposition and dysregulated profibrotic signaling. Although small interfering RNA (siRNA)-based therapies offer targeted gene silencing, their clinical application is limited by poor cellular uptake, rapid degradation, and inefficient intracellular delivery. So in our study, we aimed to develop and evaluate functionalized mesoporous silica nanoparticles (MSNs) as non-viral nanocarriers for pulmonary siRNA delivery.

Methods: Mesoporous silica nanoparticles were synthesized using a modified Stöber sol-gel method and sequentially functionalized with 3-aminopropyltriethoxysilane (APTES) and polyethylenimine (PEI, 25 kDa). Physicochemical characterization was performed using DLS, TEM, FTIR, XRD, BET analysis, TGA, and EDS. siRNA loading efficiency, release kinetics, gel retardation, and RNase protection assays were evaluated. Cellular uptake, cytocompatibility, hemocompatibility, and TGF-β gene silencing were investigated in A549 human lung alveolar epithelial cells.

Results: Surface functionalization increased particle size from 152.8 ± 8.6 nm (MSN) to 165.4 ± 10.2 nm (F-MSN- NH) and 253.2 ± 79.4 nm (MSN-PEI) and shifted the zeta potential to −19.5 ± 7.9 mV (pure MSN) to +16.1 ± 1.5 mV (F-MSN-NH) and +24.8 ± 3 mV (MSN–PEI), confirming successful amine enrichment. MSN-PEI exhibited significantly higher siRNA loading efficiency (79%) compared with unmodified MSN (40.6%). Functionalized nanoparticles demonstrated sustained and pH-responsive siRNA release, complete siRNA complexation, and effective protection against RNase-mediated degradation. Flow cytometry revealed markedly enhanced cellular uptake for F-MSN-NH (93.9%) and MSN-PEI (99.4%) compared with naked siRNA (0.1%) and unmodified MSN (12.3%). Furthermore, PEI immobilization and APTES ccoating, substantially reduced cytotoxicity and hemolytic activity while maintaining superior transfection performance. TGF-β siRNA-loaded functionalized nanoparticles achieved significant suppression of profibrotic gene expression in vitro.

Conclusion: Functionalized mesoporous silica nanoparticles represent a biocompatible and efficient non-viral platform for pulmonary siRNA delivery. Their high loading capacity, enhanced cellular internalization, nuclease protection, and gene-silencing efficacy highlight their potential as next-generation nanomedicine candidates for pulmonary fibrosis therapy.

Keywords: Mesoporous silica nanoparticles, siRNA delivery, Polyethylenimine, Pulmonary fibrosis, Nanomedicine, Gene therapy, TGF-β silencing.

Structural Basis Of Functional Divergence In Human Slc23 Transporters

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Abstract

SLC23 belongs to the nucleobase-ascorbate transporter (NAT) family, which includes the sodium-dependent ascorbate transporters SVCT1 and SVCT2. SVCT1 and SVCT2 exhibit distinct tissue-expression patterns; SVCT1 is predominantly expressed in epithelial tissues, whereas SVCT2 has a broader tissue distribution. Another member of the SLC23 family, SVCT3 (SLC23A3), was previously poorly characterised until it was demonstrated to function as a sodium-dependent hypoxanthine transporter in the human kidney.[2]

Although these proteins belong to the same transporter family, they exhibit distinct substrate specificities. What molecular features underlie this functional divergence? Despite the recent characterisation of SVCT3 function, the molecular and structural basis underlying its divergent substrate specificity relative to the ascorbate transporters SVCT1 and SVCT2 remains insufficiently characterised.

This study aims to investigate the evolutionary and structural determinants underlying functional divergence among the human SLC23 paralogs SLC23A1, SLC23A2, and SLC23A3, with particular emphasis on substrate specificity. We hypothesise that divergence in conserved functional residues and substrate-binding regions contributes to the distinct substrate specificity of SVCT3.

A reproducible comparative bioinformatics workflow will be employed using sequences of human SLC23 paralogs and relevant orthologues retrieved from publicly available databases. Multiple sequence alignment will be used to identify conserved and divergent residues and motifs, followed by phylogenetic analysis to examine evolutionary relationships within the family. Known substrate-interacting and sodium-coordinating residues identified from structurally and functionally characterised SVCT1 will be mapped to the corresponding positions in SVCT2 and SVCT3. Comparative analysis of substrate-binding regions will then be integrated with sequence conservation, evolutionary relationships, and structural features to identify candidate determinants of substrate specificity and generate testable hypotheses regarding SVCT3 function.

The analysis is expected to identify conserved structural features across the SLC23 family, residues conserved between SVCT1 and SVCT2 but divergent in SVCT3, and sequence and structural differences within or surrounding substrate-binding regions. These patterns may reveal evolutionary signatures associated with functional divergence and identify candidate molecular determinants contributing to the altered substrate specificity of SVCT3.

Understanding how paralogous membrane transporters acquire distinct substrate specificities can provide insight into transporter evolution and molecular function, while generating experimentally testable hypotheses regarding the structural determinants of SLC23A3 substrate recognition.

Keywords: SLC23, SVCT1, SVCT2, SVCT3, hypoxanthine, membrane transporters, structural bioinformatics

Development Of A Nanoparticle-based Plasmonic Biosensor For Prenatal Detection Of Fetal Abnormalities

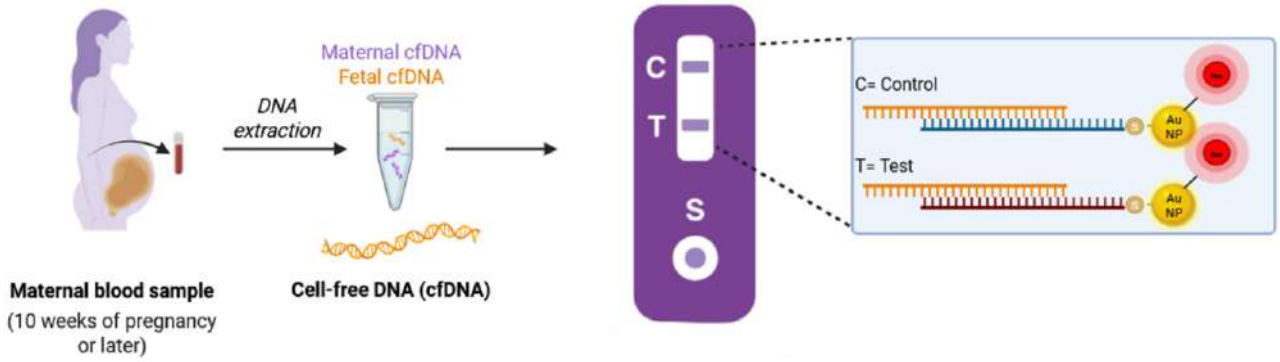
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Abstract

The concept aims to develop a cost-effective plasmonic biosensor that will focus on non-invasive technique to detect fetal genetic abnormalities using circulating cell-free DNA(cfDNA) present in maternal blood. The current non-invasive prenatal testing(NIPT) techniques are highly accurate but rely on expensive instrumentation and advanced laboratory infrastructure, which limits their use in every aspect, such as many public hospitals, rural clinics, or developing regions. The proposed biosensor is therefore designed to be simple to operate, affordable, and rapid, making it suitable for routine prenatal screening in hospitals and diagnostic laboratories.

Figure1 cfDNA-based NIPT for genetic abnormality detection



The biosensor architecture is designed through sequential conjugation of the reduced oligonucleotide probes and the Raman reporter molecule onto the AuNP surface to generate a stable plasmonic sensing interface. Upon target-specific nucleic acid hybridization, alterations in the local dielectric environment and interparticle plasmonic coupling are expected to produce measurable optical responses, enabling sensitive detection through UV–Visible spectroscopy with future integration of surface-enhanced Raman spectroscopy (SERS).

By integrating plasmonic nanotechnology with sequence-specific molecular recognition, the proposed biosensor offers a promising alternative to conventional NIPT methodologies. The platform has the potential to support affordable, scalable, and decentralized prenatal screening, thereby expanding access to molecular diagnostics and advancing point-of-care nanodiagnostic technologies.

Keywords: Plasmonic biosensor; Gold nanoparticles; Oligonucleotide; Prenatal diagnosis; Raman reporter molecule; NIPT

Decoding Parkinson's Through Vocs: a Non-invasive Sebum-based Electrochemical Sensor for Parkinson's Disease Detection

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Abstract

Parkinson's disease (PD) is typically recognized after motor symptoms emerge, when substantial dopaminergic neuronal loss may already have occurred. The search for accessible molecular signatures that can be measured before or alongside overt symptoms has therefore become increasingly important. Sebum has recently emerged as an unconventional, non-invasive biofluid containing volatile molecules associated with PD. Here, we report a low-cost, non-enzymatic electrochemical platform for detecting perillaldehyde, a sebum-associated candidate biomarker, using a flexible gold electrode on polyimide. The three-electrode chip was fabricated by patterning followed by thermal deposition of titanium and gold, with an optimized Au thickness. Unlike enzyme- or affinity-reagent-based biosensors, the platform relies on direct electrochemical oxidation of perillaldehyde, producing a distinct cyclic-voltammetric response near 1.2 V. The sensor exhibited a linear response from 10 to 500 µM with a limit of detection of 9.4 µM and maintained selectivity in the presence of glucose, uric acid, octanal, glycerol and glycolic acid. Importantly, analysis of sebum samples showed pronounced signal changes for Parkinson's patient samples compared with controls, supporting the translational potential of this skin-derived chemical signature. The disposable sensor strip costs approximately 7 (~US$0.08) and can be coupled with a portable potentiostat and smartphone-based readout. By converting a skin-derived volatile biomarker into an immediately measurable electrical signal, this approach offers a simple and scalable route toward non-invasive, decentralized PD screening and highlights sebum as a promising analytical window for next-generation neurodiagnostics.

Keywords: Parkinson's disease, Perillaldehyde, Sebum, Electrochemical sensor, Non-invasive screening, Point-of-care

AI-Powered Digital Twins Technology in Designing Personalized Biomaterials for Chronic Wound Healings

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Abstract

Chronic wounds are persistent injuries that fail to progress through the normal stages of healing within 4 to 12 weeks, resulting in prolonged inflammation, impairing tissue repair and regeneration, posing a major healthcare and economic burden. Traditional treatment for chronic wounds relies on antibiotic therapy to control pathogenic infections. However, this widespread misuse and overuse of antibiotics has contributed to the rapid emergence of antibiotic resistance (AMR), including multidrug-resistant (MDR) pathogens, thereby hindering infection control and optimal wound care. In response to this challenge, engineered biomaterials have emerged as a promising platform with isotropic or anisotropic structures that mimic the biological extracellular matrix and play a major role in several essential metabolic functions.

However, limitations remain in designing and optimizing the biomaterials, as the process depends on conventional manufacturing methods and trial-and-error approaches, which are labour-intensive, time-consuming, costly and require the testing of countless material combinations. Moreover, without an optimized and reproducible formulation, it is difficult to develop an ideal biomaterial. To address these issues, AI-powered digital twin technology (DTT) provides a promising framework that integrates real-time, patient-specific clinical, imaging, microbial, and physiological data to design personalized biomaterial-based treatment strategies to combat MDR pathogens. This approach can support the design of smart biomaterials with controlled drug release, enhanced antimicrobial activity, and improved tissue regeneration. Machine learning (ML), deep learning (DL), and generative AI accelerate the prediction of biomaterial properties, drug-loading efficiency, release kinetics, antimicrobial activity, cytotoxicity, and biological performance while reducing experimental costs and development time. Ultimately, an AI-driven DTT approach may accelerate the development of effective therapies for chronic wounds, particularly those complicated by MDR infections and promote chronic wound healing. Although this technology appears highly promising, it still needs substantial research for further future development.

Keywords: Chronic Wound, Multidrug-resistant pathogens, Artificial intelligence, Digital twin technology, Machine learning, Deep learning, Personalized Biomaterial.

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Development And Validation of an Analytical Gradient UHPLC Method for The Simultaneous Quantification of Cytarabine and Apigenin

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Abstract

Cytarabine (CYT), for the last fifty years, has been the standard first-line therapy for treatment of acute myeloid leukemia(AML) in adult patients. However, AML patients develop resistance to anti-leukemic agents and young patients achieve only 40-50% complete remission. Thus, combination of chemotherapeutic agents with polyphenols have emerged as a promising treatment option in AML which improves the survival rates of patient and also improve the clinical outcome and response to chemotherapy. Apigenin (APIG), a polyphenol found in vegetables, fruits and herbs such as carrots and celery act as a powerful chemosensitizing agent in AML and decrease the chances of drug resistance and adverse effects while improving the efficacy of chemotherapeutics. Thus, this calls for the development of a robust analytical method for the simultaneous quantification of CYT and APIG. We have developed a simple, robust, and cost-effective gradient RP-UHPLC method for the simultaneous estimation of CYT and APIG with a run time of 15 min. Chromatographic separation was achieved on a C8 column (250 × 4.6 mm). The gradient elution employed mobile phase A (0.1% orthophosphoric acid), mobile phase B (methanol), and mobile phase C (acetonitrile) with a flow rate of 0.7 ml/min. The developed method was further validated for linearity, selectivity, robustness, accuracy and precision with %RSD less than 2. The developed method provides a reliable analytical tool for the simultaneous quantification of both drugs which can be applied for quantification in the prepared nanoparticulate drug delivery system.

Keywords: Cytarabine, Apigenin, AML, UHPLC, Gradient, Validation

Hesperetin-loaded Transethosomal Gel: A Promising Nanovesicular Strategy For Topical Anti-candida Biofilm Therapy

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Abstract

Candida albicans is an important fungal pathogen capable of forming biofilms, which contribute to persistent infections and reduced susceptibility to antifungal therapy. Hesperetin is a naturally occurring flavanone with reported antimicrobial and anti-biofilm properties and has demonstrated activity against Candida species. However, its limited aqueous solubility may restrict its incorporation and availability in conventional topical formulations. The present study focuses on the development and optimization of a Hesperetin-loaded transethosomal gel as a topical nanovesicular system for anti-candida biofilm activity. Hesperetin-loaded transethosomes will be prepared using phospholipid, ethanol and an edge activator. Three preparation approaches, namely ethanol injection, thin-film hydration and cold method, will be investigated and compared on the basis of formulation characteristics and suitability for Hesperetin. The selected method will be optimized using a three-factor, three-level Box–Behnken Design, with Phospholipon 90G, ethanol and Tween 80 as formulation variables. The prepared transethosomes will be characterized for vesicle size, polydispersity index, zeta potential, entrapment efficiency and deformability. The optimized transethosomal dispersion will subsequently be incorporated into Carbopol 940 gel and evaluated for pH, viscosity, spreadability, homogeneity, drug content, in-vitro drug release and stability. The antifungal potential of Hesperetin and the optimized formulation will be evaluated against C. albicans through minimum inhibitory concentration and minimum fungicidal concentration studies, followed by assessment of biofilm inhibition using the Crystal Violet assay. Comparative evaluation of free Hesperetin and the transethosomal gel will be used to determine the contribution of the nanovesicular system to topical delivery and anti-biofilm performance. The study is expected to establish a suitable transethosomal formulation with desirable physicochemical characteristics and improved local drug delivery. The developed Hesperetin-loaded transethosomal gel may provide a promising approach for enhancing the topical application of Hesperetin against Candida biofilm-associated infections.

Keywords: Hesperetin; Transethosomes; Topical Drug Delivery; Candida albicans; Biofilm Inhibition

Multifunctional Biofortified Hybrid Nerve Guidance Conduit Restores Redox Homeostasis To Promote Peripheral Nerve Regeneration And Hippocampal Neuroprotection.

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Abstract

Peripheral nerve injury (PNI) remains an unmet clinical challenge because autologous nerve grafting is constrained by donor-site comorbidity and neuroma formation, while current nerve guidance conduits(NGCs) mainly provide structural support without modulating the oxidative and inflammatory microenvironment that impairs regeneration and contributes to secondary hippocampal dysfunction. To overcome these limitations, hybrid multifunctional NGCs were developed by integrating an electrospun poly(ε-caprolactone) nanofibrous sheath with injectable alginate-collagen hydrogels biofortified with ayurvedically processed mica nanominerals and natural antioxidants from Karvi honey (KH) or syringic acid (SA). Biofortified hydrogels were physicochemically characterized and validated in an H_2O_2-induced in vitro oxidative stress model, exhibiting sustained antioxidative bioactives release, multicellular cytocompatibility (Schwann cell, fibroblast, and hippocampal cell), suppression of intracellular reactive oxygen species (ROS), restoration of mitochondrial membrane potential, attenuation of apoptosis through activation of the NRF2/SOD2 pathway, and excellent hemocompatibility. In the Sprague-Dawley rat sciatic nerve injury model, hybrid NGCs enhanced multicellular tissue regeneration, axonal remodeling, remyelination, gastrocnemius muscle preservation, synaptic maturation, thermal nociception, and improved motor function as evidenced by rotarod, actophotometer performance while limiting fibrosis in the injury site. Concomitantly, it reduced TNF-α/NLRP3-mediated neuroinflammation and restored hippocampal BDNF and neuronal integrity within the dentate gyrus, CA1, and CA3 regions, demonstrating modulation of the peripheral nerve-brain axis. Especially, KH biofortified hydrogel-loaded NGCs conferred more therapeutic benefits, highlighting a promising multifunctional translational strategy for simultaneously promoting peripheral nerve regeneration and mitigating secondary central neurodegeneration.

Keywords: Peripheral nerve Injury, Nerve guidance conduit, Biofortified injectable hydrogel, Bioactive mica particle, Oxidative microenvironment, Peripheral-Brain axis, Neuroregeneration.

Silver Nanoparticle-embedded Covalent Organic Framework (ag@cof): A Concentration-dependent Antibacterial Nanocomposite Against Gram-positive and Gram-negative Pathogens

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Abstract

Covalent organic frameworks (COFs) offer tunable porosity and chemical stability for biomedical applications but often require additional functional components to gain direct antimicrobial activity. Embedding silver nanoparticles (AgNPs) within a COF scaffold can prevent nanoparticle aggregation while imparting antibacterial function, although protein-level interactions of such metal-COF hybrids remain largely unexplored. Herein, a silver nanoparticle-embedded COF (Ag@COF) was synthesized via solvothermal imine condensation of p-phenylenediamine and terephthalaldehyde, followed by post-synthetic incorporation of AgNPs. The composite was characterized by PXRD, FTIR, FESEM, TEM, XPS, Raman and BET analyses, confirming a uniform AgNP distribution (36.01 wt%) on the COF surface. Protein compatibility was assessed using lysozyme as a model protein via UV-Vis, fluorescence and circular dichroism spectroscopy, supported by molecular docking and density functional theory (DFT) calculations. Docking revealed a binding energy of −214.0 kJ/mol for the lysozyme-Ag@COF complex, with classical and non-classical hydrogen bonds together with Ag-protein metal bonds indicating stable, non-covalent interactions that preserved the protein's native secondary and tertiary structure. Antibacterial evaluation against Escherichia coli and Enterococcus faecalis by microbroth dilution showed concentration-dependent inhibition, with minimum inhibitory concentration (MIC) values of 64 µg/mL and 128 µg/mL, respectively. Scanning electron microscopy and energy-dispersive X-ray spectroscopy (EDAX) of treated bacterial cells confirmed membrane disruption and silver deposition on the bacterial surface, consistent with a multi-pathway antibacterial mechanism involving physical membrane damage, reactive oxygen species generation, and inhibition of bacterial respiratory enzymes. Collectively, these findings demonstrate that Ag@COF combines structural stability, protein biocompatibility, and broad-spectrum antibacterial efficacy against both Gram-negative and Gram-positive pathogens, supporting its potential as a next-generation antimicrobial biomaterial for biomedical applications. Further in vivo studies are warranted to validate its broader translational applicability.

Functionalization And Characterization of a Naturally Occurring Starch Biopolymer for its Potential Application in Cosmetic Formulations for Cutaneous Aging.

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Abstract

Cutaneous aging arises from cumulative oxidative damage, progressive collagen degradation, and diminished epidermal turnover, necessitating next-generation dermal delivery systems for retinoids [1]. Despite proven efficacy, conventional retinoid therapies are severely constrained by photolability, limited transdermal penetration, and dose-dependent irritancy [2]. This study introduces a biocompatible nanocosmeceutical platform comprising glycolic acid modified lotus stem starch polymeric nanoparticles (PNPs) engineered for stabilized, sustained, and deep dermal delivery of retinyl acetate. Starch isolated from Nelumbo nucifera stems exhibited amorphous–crystalline morphology, having particle size 10–50 µm, and onset degradation beyond 300 °C. Esterification with alpha-hydroxy acid (AHA) conferred enhanced lipophilicity, thermal resistance, and intrinsic exfoliative/anti-aging synergy, consistent with recent reports on chemically modified polysaccharide nanocarriers [3]. Retinyl acetate was encapsulated by nanoprecipitation, and formulation was systematically optimized using a three-level Box–Behnken design, evaluating polymer concentration (A), surfactant concentration (B), and stirring speed (C). Highly predictive quadratic models ($R^2 > 0.95$, $p < 0.0001$) were obtained for particle size (R1), entrapment efficiency (R2), and drug loading (R3), aligning with optimization trends observed in contemporary nanocosmeceutical studies [4]. The optimized PNPs yielded monodisperse spherical nanoparticles of 350 ± 15 nm, zeta potential –25.4 mV, 65.8 ± 2.1 % entrapment efficiency, and 1.52 ± 0.08 % drug loading, with markedly improved photostability and controlled-release behaviour, consistent with performance benchmarks for natural-polymer nanocarriers [5]. This green, biodegradable platform integrates natural polymer functionality with precision nano-engineering, offering superior retinoid stabilization, reduced irritancy, and facilitated stratum corneum bypass. Ongoing in vitro and in vivo investigations are assessing its ability to counter oxidative-stress induced senescence, stimulate extracellular-matrix remodeling, and restore aged-skin architecture.

Acknowledgement(s): Drug Delivery Research Lab (DDRL), Department of Pharmaceutical Sciences, Dibrugarh university.

Keywords: Skin aging; Retinol; Nanoparticles; Polymeric carriers; Anti-aging therapy; Nano-cosmeceuticals.

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Tetraniline-Engineered Nickel Molecular Frameworks for Combinatorial NIR-Triggered Photothermal and Photodynamic Cancer Therapy

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Abstract

Near-infrared (NIR)-responsive nanomaterials are of critical importance for biomedical applications owing to their superior tissue penetration depths. Herein, we present a rational design of NIR-responsive tetraniline (TANI)-engineered nickel coordination frameworks for multimodal cancer phototheranostic applications. These frameworks represent an advanced class of hybrid materials, combining the redox activity and electrical conductivity of oligomeric aniline along with the structural versatility of nickel-based frameworks or related coordination polymers. To the best of our knowledge, this work represents the first report of a nickel-tetraniline coordination framework (NTF) employing tetraniline as the organic linker, resulting in a porous and aqueous-dispersible platform with NIR absorption properties. Upon NIR light excitation in the first biological window (650–950 nm), NTFs demonstrate dual-mode theranostic functionality, simultaneously generating ROS and inducing potent photothermal and photodynamic therapeutic effects. The framework also displays measurable magnetic relaxivity and enables loading of fluorescent probes such as indocyanine green, highlighting its potential for theranostic and multimodal imaging applications. This scalable strategy offers a structurally versatile NIR-responsive combinatorial theranostic nanoplatform, holding significant promise for next-generation biomedical applications.

Keywords: Metal-organic frameworks, tetraniline, near infrared light, photothermal therapy, photodynamic therapy, ovarian cancers.

Transcriptomic And Proteomic Disruption Of Oncogenic Cascades And Antibiofilm Efficacy Induced By Green-synthesized Tridax Procumbens Silver Nanoparticles

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Abstract

The rising global burdens of drug-resistant advanced malignancies and biofilm-forming bacterial pathogens necessitate novel therapeutic modalities. This study aims to evaluate the biogenic green synthesis, physicochemical characterisation, and dual-action biomedical efficacy of stable, spherical silver nanoparticles synthesised using Tridax procumbens leaf extracts (TNPs) [1]. Physicochemical profiling revealed an average particle size of 10 nm, while high-resolution liquid chromatography-mass spectrometry denotes a surface library of 38 unique capping phytochemicals, including Pterosin H, Brassilexin, and solanidine. In-vitro cytotoxicity assays demonstrated potent concentration-dependent anticancer activity against A549 lung cancer cells IC50 = 10.70 µg/mL, B16F10 melanoma cells IC50 = 5 µg/mL, and A431 skin cancer cells IC50 = 4 µg/mL. Functional scratch and clonogenic assays showed severe impairment of tumour cell migratory capacity and long-term reproductive rejuvenation. Internalisation kinetics confirmed that TNPs successfully translocated from the cytoplasm into the cell nucleus within 48 hours, triggering rapid intracellular reactive oxygen species production and oxidative stress. High-throughput transcriptomic and proteomic analyses identified structural system failure through downstream disruption of vital survival cascades, with significant repression of mTOR signalling, cell cycle progression, and mineral absorption, alongside robust induction of macro-autophagy. Furthermore, TNPs exhibited superior antimicrobial and antibiofilm potency compared with ceftazidime against clinical multidrug-resistant environmental isolates, including Carbapenem-Resistant Pseudomonas aeruginosa (CRPA) [2,3], yielding Minimum Inhibitory Concentrations (MICs) ranging from 8 to 16 µg/mL. In conclusion, eco-friendly synthesised TNPs provide a powerful, high-efficiency, multifactorial therapeutic platform capable of simultaneously targeting advanced therapeutic malignancies and recalcitrant microbial biofilms.

Keywords: Tridax procumbens, Green Synthesis, Silver Nanoparticles, mTOR Signaling, Autophagy, Carbapenem-Resistant Pseudomonas aeruginosa, Biofilm Eradication.

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Bhasma and Green-Synthesized Nanoparticles : A Comparative Analysis of Traditional and Modern Nanomedicine Synthesis

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Abstract

Ayurvedic Bhasma and modern green-synthesized nanoparticles rest on a shared principle: both transform toxic metals into biocompatible, nanoscale therapeutics using plant-derived phytochemicals as reducing and capping agents. This review compares the two synthesis traditions across process, characterization, biomedical efficacy, and standardization.

Materials and Methods: Bhasma preparation follows the iterative sequence of Shodhana (purification), Bhavana (levigation with herbal juices), and Marana (repeated calcination) — a time- and labour-intensive route to organometallic nano-complexes. Green synthesis reaches a comparable endpoint through a single, rapid, ambient-temperature reaction, in which flavonoids, polyphenols, and terpenoids present in plant extracts reduce and stabilize metal ions.

Results: At the physicochemical level, traditional Ayurvedic Bhasma preparation and modern green nanoparticle synthesis produce strikingly similar end products, a convergence that has been consistently demonstrated through parallel characterization using XRD, SEM, TEM, FTIR, DLS and EDX. Together, these complementary techniques reveal comparable nanoscale particle dimensions, crystalline phases, elemental composition, and phytochemical surface functionalization in both methods. This similarity is evident across multiple metallic formulations. Loha Bhasma closely resembles Triphala-mediated iron nanoparticles in its physicochemical characteristics, while Rajat Bhasma shares nanoparticle morphology, size distribution, and characteristic silver EDX peaks near 3 keV with biosynthesized silver nanoparticles. A similar nanoscale architecture has also been reported for Vanga Bhasma, which consists predominantly of particles in the 50–100 nm range. Likewise, cycle-wise characterization of Jasada Bhasma demonstrated a progressive reduction in particle size from approximately 1.5 µm rod-shaped structures to nanoparticles averaging about 31 nm, with some as small as 10 nm. These physicochemical similarities are mirrored in their biological activities showing comparable anticancer efficacy against MCF-7 cells. Likewise, green-synthesized CuO nanoparticles demonstrated superior antibacterial and anticancer activities, along with reduced toxicity in zebrafish embryo models, compared with chemically synthesized CuO nanoparticles.studies and encouraging clinical benefit in a pilot clinical trial involving patients with breast cancer.

Collectively, these findings suggest that traditional Ayurvedic processing and green nanotechnology converge toward the production of structurally analogous, biocompatible nanomaterials with enhanced antibacterial, anticancer, antioxidant, and immunomodulatory (Rasayana) properties. In both approaches, transforming metals into the nanoscale appears to enhance therapeutic efficacy while reducing the toxicity associated with their bulk counterparts. This convergence is further exemplified by Nano Swarna Bhasma, a gold nanoparticle formulation synthesized using phytochemicals from mango, turmeric, and gooseberry, which demonstrated dose-dependent tumour suppression in preclinical

Keywords: Bhasma Green Synthesis Nanoparticles Ayurveda Phytochemicals Nanomedicine Biocompatibility

ICG-Loaded Hollow Cu2MoS4 Nanoreactor for synergistic Photodynamic, Photothermal, Chemodynamic and Starvation Therapy for Enhanced Breast Cancer Treatment

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Abstract

Breast cancer is one of the major challenges in cancer therapy, because a single treatment approach is often insufficient to overcome the complex tumor microenvironment. In this study, we developed a porous hollow Cu MoS nanoreactor for combining four therapeutic strategies- photodynamic therapy (PDT), photothermal therapy (PTT), chemodynamic therapy (CDT), and starvation therapy in a single platform. The hollow and porous structure of Cu MoS provides sufficient space for loading indocyanine green (ICG), while its intrinsic near-infrared photothermal response enables efficient heat generation for PTT.

Following NIR irradiation, the loaded ICG generates singlet oxygen (^1O), providing an additional PDT effect alongside the intrinsic PTT activity of Cu MoS . To introduce starvation therapy, glucose oxidase (GOx) is incorporated into the nanoparticle to consume glucose within the tumor environment, deprive cancer cells of their primary energy source while producing H O . The generated H O participate in Cu/Mo-mediated catalytic reactions to produce highly reactive oxygen species, thereby enhancing CDT. In parallel, depletion of intracellular glutathione weaken the antioxidant defense of tumor cells and further amplify oxidative stress.

The proposed system therefore creates a cascade in which glucose depletion, H O generation, catalytic ROS production, ICG-mediated ^1O generation, and NIR-induced hyperthermia work together to overcome the limitations of individual therapies. By integrating metabolic starvation with photochemical, photothermal, and catalytic therapeutic mechanisms, ICG@H-Cu MoS is expected to provide enhanced and synergistic killing of breast cancer cells. This work presents a strategy for developing a multifunctional hollow nanoreactor in which the intrinsic properties of Cu MoS are combined with ICG-mediated PDT and GOx-mediated starvation to achieve more effective breast cancer treatment.

Keywords: Cu_2MoS_4 nanoreactor; Indocyanine green; Photodynamic therapy; Chemo dynamic therapy; Starvation therapy

2d-hydrogen Substituted Graphdiyne Based Electrochemical Biosensor For Heart Attack Detection

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Abstract

Cardiac troponin I (cTnI) is the prognostic biomarker for heart attack, where its ultrasensitive detection is crucial for monitoring of disease progression and timely medical treatment1. However, conventional cTnI detection techniques remain limited by insufficient sensitivity, lack of ultralow concentration detection along with prolonged assay duration2. In this regard, porous two-dimensional (2D) nanomaterials have emerged as promising immobilization matrices for development of ultraefficient electrochemical biosensing platform3. In this work, mesoporous hydrogen substituted graphdiyne (HsGDY) has been synthesized through modified Glaser–Hay coupling reaction and utilized as the immobilization matrix for fabrication of an electrochemical biosensor to detect cTnI. The synthesized HsGDY has been characterized using X-Ray Diffraction, Transmission Electron Microscopy, Scanning Electron Microscopy, Fourier Transform Infrared Spectroscopy and Porosimeter. The synthesized nanomaterial exhibited a mesoporous framework with a BET surface area of 105.23 $m^2 g^{-1}$ and average pore size of ~6.2 nm. Subsequently, HsGDY was electrophoretically deposited onto indium tin oxide (ITO) coated glass electrodes, followed by immobilization of monoclonal anti-cTnI antibodies (anti-cTnI) and bovine serum albumin (BSA). Finally, the fabricated immunosensors (BSA/anti-cTnI/HsGDY/ITO) were electrochemically characterized using differential pulse voltammetry (DPV), where it shows excellent sensitivity of 1.68 μA [log (ng mL^{-1})]$^{-1}$ cm^{-2} with wider linear detection range from 10 ag mL-1 to 10^3 ng mL^{-1} and lower detection limit of 9 ag mL^{-1} (~5 molecules of cTnI) with a shelf life of 28 days. The developed biosensor also evaluated in serum biofluid which shows an excellent correlation with the standard samples.

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Stereoselective Thiosulfonylation Of Alkynes Using Sodium Thiosulfate As A Sulfur Transfer Agent To Access Bis-(z)-vinyl Sulfones

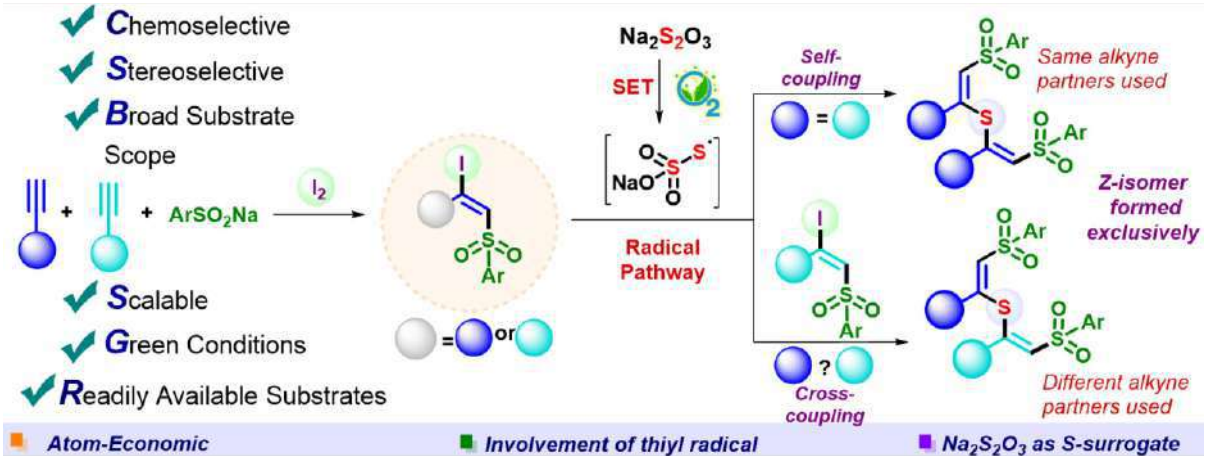
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Abstract

Organosulfur compounds are important in organic synthesis because of their diverse chemical and biological applications. In this work, we report a novel and efficient reactivity profile of sodium thiosulfate (Na2S2O3) as an odorless, inexpensive, non-toxic, and environmentally benign sulfur-transfer reagent. Sodium thiosulfate serves as a sulfur surrogate for hydrogen sulfide (H2S), enabling the in-situ generation of reactive sulfur species under metal- and acid-free conditions. The developed methodology allows the direct thiosulfonylation of a broad range of terminal and internal alkynes, providing synthetically valuable bis-(Z)-vinyl sulfones with high stereoselectivity. The reaction offers a practical alternative to conventional sulfur reagents, which often suffer from unpleasant odours, toxicity, moisture sensitivity, or limited scalability. Overall, this approach provides a simple, sustainable, and environmentally friendly strategy for the stereoselective construction of (Z)-vinyl sulfones and sulfur-containing molecules, highlighting the potential of sodium thiosulfate as a versatile sulfur source in organic synthesis.

Keywords: Stereoselective thiosulfonylation, Sulfur transfer agent, Bis-(Z)-vinyl sulfones, Metal-free conditions.



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Combinatorial Targeting of Transcription and Microtubule Dynamics: Actinomycin D-Noscapine Synergy in Lung Cancer

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Abstract

Non-small cell lung cancer (NSCLC) remains a therapeutic challenge, as treatment resistance and dose-limiting toxicity continue to be a challenge to conventional chemotherapy [1]. Combining agents with complementary mechanisms of action can improve anticancer efficacy while allowing dose reduction of both agents. This study explored the therapeutic efficacy and underlying mechanism of combining Actinomycin D (ActD), a transcriptional inhibitor [2], with Noscapine, a microtubule-interfering agent with recently identified anticancer activity [3], in NSCLC. The anticancer effects of ActD and Noscapine, alone and in combination, were evaluated in A549 and H1299 human NSCLC cell lines. Cytotoxicity was measured by MTT assay and quantified mathematically using the Combination Index (CI) [4]. The impact of combination therapy on cellular motility and apoptosis was assessed through migration and apoptosis assays, respectively. Gene-expression changes linked to apoptosis induction, cell survival, and tumour-related processes were determined by PCR-based gene-expression analysis, providing further insight into the events underlying the combination response. Molecular modelling was additionally used to probe the pathways involved and help interpret the observed combination effect. The ActD-Noscapine interaction was synergistic, as indicated by the CI values obtained, suggesting greater anticancer activity than either drug alone. Combination treatment produced a complete blockade of NSCLC cell migration and a significant increase in apoptotic response in both A549 and H1299 cells. PCR analysis of genes involved in apoptotic signalling and cell survival indicated regulation of apoptosis by the drugs alone and in combination, pointing to compensatory mechanisms. In silico analysis provided further insight into the possible molecular interactions, suggesting that the transcriptional disruption caused by ActD and the mechanism of action of Noscapine may converge on pathways regulating tumour-cell survival and progression. These findings indicate that Noscapine can enhance the anticancer efficacy of ActD in NSCLC cells by promoting migration suppression and apoptosis while regulating known molecular pathways, and that this combination improves further exploration in a dose-releasing manner for NSCLC therapy. The next phase of this work involves Western blot analysis of the relevant molecular targets and the design of a liposomal delivery vehicle for both drugs, enabling incorporation of additional targeted agents and enhanced drug delivery.

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A Dissolvable Microneedle Platform for Localized Chemo–Photothermal–Photodynamic Breast Cancer Therapy Using Gold Nanocapsules Co-Loaded with Indocyanine Green and Cisplatin

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Abstract

Abstract: Localized cancer therapy is often limited by inadequate drug accumulation at the tumor site, systemic toxicity, and poor therapeutic selectivity. To address these challenges, we developed a dissolvable microneedle (MN) patch for the localized delivery of gold nanocapsules (AuNCap) co-loaded with indocyanine green (ICG) and cisplatin, designed to enable synergistic chemo–photothermal–photodynamic therapy for breast cancer. The AuNCap were engineered as near-infrared (NIR)-responsive nanoplatforms capable of converting light into localized heat while simultaneously serving as carriers for a photosensitizer and a chemotherapeutic agent. Incorporation of these nanocapsules into a dissolvable MN matrix enabled efficient transdermal administration and localized retention, supporting targeted delivery directly to the tumor region. Following NIR irradiation, the platform produced potent multimodal anticancer effects through hyperthermia, reactive oxygen species generation, and cisplatin-mediated DNA damage, resulting in amplified tumor cell death. The integrated therapy showed superior antitumor efficacy compared with monotherapies, with enhanced tumor suppression and effective activation of apoptosis pathways. Importantly, the MN-based delivery strategy improved local drug exposure while minimizing systemic distribution, thereby reducing the risk of off-target toxicity. In vivo studies confirmed significant inhibition of tumor growth without detectable systemic adverse effects, and the MN patch demonstrated desirable mechanical properties and rapid dissolution upon skin insertion. Overall, this study introduces a minimally invasive and highly effective nanomedicine platform for localized breast cancer treatment. By combining site-specific delivery with multimodal therapeutic action, this approach offers a promising translational strategy for improving the safety and efficacy of cancer therapy.

Keywords: Microneedles, Localized Drug Delivery, Breast Cancer, Gold Nanocapsules, Photothermal Therapy, Photodynamic Therapy, Nanomedicine.

Targeted Gene Downregulation In Glioblastoma By Drug Repurposing Via Green Synthesized Zirconium Metal Organic Framework Nanocarriers

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Abstract

Glioblastoma multiforme (GBM) is the most common type of malignant brain tumor prevalent in the world today with limits to existing therapies. The main reason for the lack of successful prognosis is the impenetrative nature of the blood Brain Barrier (BBB) and unclear underlying biological and genetic mechanisms. This makes it very difficult for drugs to reach the targeted tumors. Developments in nanotechnology and their collaboration with drug delivery research has allowed the conjugation of a variety of nano-carriers with drugs that allow them to pass through the BBB for targeted delivery, especially biomimetic drugs. Green synthesized nanocarriers offer better sustainability, greater biosafety and absorption by the body with higher bioactivity.

This proposal aims to computationally identify differentially expressed genes in GBM tumors using the available TCGA-GTEx datasets. Upregulated gene targets shortlisted include TOP2A and BRIC5.

Drug Repurposing and novel metal organic frameworks is an upcoming therapeutic design that has not yet been combined to test on GBM cell lines extensively. This project would utilize available iLINCS databases to choose a gene-repressing drug candidate that will be repurposed to test in GBM tumor cells.

UiO-66 Metal Organic Framework Core-shell nano-carriers will be green synthesized for drug loading. Chitosan-Hyaluronic acid interlayers will be integrated for pH-responsive delivery and CD44 targeting. Homotypic GBM Cell membrane will be functionalized as the outer shell for biomimetic properties, especially useful in crossing the BBB.

The formulated nano-carriers will undergo TEM, UV-Visible spectroscopy, DLS, FTIR and Zeta Potential analysis. Targeted drug delivery will be tested in U-87MG or U251 cell lines to be confirmed by MTT assay, qPCR and SDS-Page Western Blot.

Keywords: Glioblastoma, TOP2A, BRIC5, Homotypic Nanocarriers, Drug Repurposing

Role Of Modern Tools In Standardization Of Incinerated Metal W.s.r. To Vanga Bhasma – A Review

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Abstract

Bhasmas are Ayurvedic herbo-mineral/metallic preparations whose quality, safety and efficacy depend critically on proper standardization. Classical parameters described in Rasa Shastra texts — Varna (colour), Varitara, Rekhapurnatva, Apunarbhava and Niruttha — offer qualitative assessment of Bhasma, but the growing use of Bhasma in contemporary practice demands standardization supported by objective, reproducible, instrument-based evidence. Vanga Bhasma (incinerated tin oxide preparation) was selected as the representative metal Bhasma for this review.

Objective: To evaluate the role of modern analytical tools — X-Ray Powder Diffraction (XRD), X-Ray Fluorescence Spectroscopy (XRF), Energy-Dispersive X-ray Spectroscopy coupled with Scanning Electron Microscopy (EDX-SEM), and Particle Size Analysis (PSA) — in the standardization and characterization of Vanga Bhasma, based on a compilation of previous research.

Methods: An extensive review and compilation of relevant Post-Graduate and Ph.D. research work from the Department of Rasa Shastra Evam Bhaishajya Kalpana, National Institute of Ayurveda, Jaipur, together with peer-reviewed articles indexed on PubMed and other scientific journals, was carried out to screen data on instrumental characterization of Vanga Bhasma.

Results: XRD analysis consistently identified the crystalline phase of Vanga Bhasma as Cassiterite-type tin oxide (SnO), with characteristic 2θ diffraction peaks near 26.6°, 34.0° and 51.8° reproduced across independent studies (Table 1, Fig. 1). XRF and EDX-SEM analyses confirmed SnO as the major constituent (approximately 72.7–97.4%), along with minor and trace oxides such as CaO, SiO , K O, Fe O /FeO, Al O , MgO, PbO and CdO (Table 2). SEM imaging revealed granular, porous particle morphology without a defined crystalline pattern at the micro-scale, while EDX confirmed the presence of Na, Mg, Al, Si, S, Fe and O. Particle size analysis showed a fine, coarse-nanoparticle to micron-range distribution (median particle size, X50, of approximately 5.5–7.9 µm across studies), supporting the classical Rekhapurnatva criterion.

Conclusion: Modern Analytical Tools Such As Xrd, Xrf, Edx-sem And Psa Provide Objective, Reproducible And Complementary Data On The Crystalline Structure, Elemental/oxide Composition And Particle Size Of Vanga Bhasma, And Correlate Well With Classical Ayurvedic Parameters Of Bhasma Examination. Combined Use Of These Techniques, Particularly Xrd And Xrf Together, Enhances The Accuracy Of Phase Identification And Quantitative Analysis, And Is Recommended For The Routine Standardization And Quality Assurance Of Metal-based Bhasma Preparations.

Keywords: Vanga Bhasma Standardization Xrd Xrf Edx-sem Particle Size Analysis

Noble Metal decorated Zinc Oxide Nanocomposite for Sensitive and Selective Electrochemical Detection of Ketamine in Complex Beverage Matrices

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Abstract

Ketamine, a dissociative anaesthetic and non-competitive antagonist of the N-methyl-D-aspartate receptor, is increasingly encountered as a drug-facilitating agent in beverage spiking, which demands rapid, sensitive and field-deployable detection strategies. In this study, zinc oxide (ZnO) nanocomposite and their silver and gold decorated composites, Ag@ZnO and Au@ZnO, were successfully synthesised via a starch-assisted precipitation route followed by in-situ chemical reduction and were comparatively evaluated for their electrocatalytic performance toward ketamine. The nanomaterials were systematically characterised using XRD, XPS, FESEM, TEM, EDS and BET analysis to confirm their structural, compositional, morphological and textural features. Electrochemical investigations using EIS, CV and DPV revealed that silver decorated composite significantly enhanced electron-transfer kinetics, the charge-transfer resistance decreasing from 30 kΩ for ZnO/GCE to 21 kΩ for Ag@ZnO/GCE, and that the anodic response toward ketamine oxidation increased in the order bare GCE < Au@ZnO < ZnO < Ag@ZnO. The dependence of the anodic peak potential on pH (−48.9 mV pH−1) established a proton-coupled, amine-centred oxidation pathway that is strongly favoured under alkaline conditions. Among the tested materials, the Ag@ZnO nanocomposite exhibited the highest sensitivity, achieving a low detection limit of 10µM over a linear range of 10 to 100 µM, outperforming both pristine ZnO and Au@ZnO. The developed sensor was successfully applied to the determination of ketamine in spiked soft-drink and whisky samples with satisfactory recoveries and minimal interference, demonstrating the potential of noble-metal-decorated ZnO nanocomposite as reliable sensing platforms for forensic screening.

Keywords: Zinc oxide nanocomposite; silver decoration; metal-support interaction; electrochemical sensing; ketamine

Nanoarchaeosomes as Archaeal Lipid-Based Nanocarriers for Enhanced Paclitaxel Therapy Against Glioblastoma

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Abstract

Glioblastoma (GBM) is an aggressive and hostile cancer condition that affects the central nervous system and occurs due to genetic and environmental factors. It is primarily characterised by rapid proliferation and extensive infiltration into the surrounding brain tissues, expressing high angiogenic potential with a remarkable capacity to evade therapeutic intervention. Despite advances in neurosurgery, radiotherapy and chemotherapy, an urgent need for more effective treatment strategies to overcome the drastic effects of glioblastoma remains. Further, the potential anti-cancer drug paclitaxel (PTX) exhibits anti-cancer activity but displays poor solubility and limited drug delivery to brain tumours. To overcome this, archaeal lipid-based nanoarchaeosomes (NA) have emerged as more promising nanocarriers exhibiting exceptional physicochemical stability and biocompatibility. In the present study, PTX-loaded nanoarchaeosomes (NAPTX) were synthesised and evaluated for their anti-glioblastoma efficacy.

Materials and Methods: The nanoformulation (NAPTX) was synthesised using the thin dry-film hydration method utilising the sonication method. The nanoformulation were characterised and confirmed by SEM, DLS and FTIR techniques. Further, the cytotoxic effect was evaluated in primary GBM cells using the MTT assay. Additionally, the intracellular changes, such as ROS generation, mitochondrial membrane potential depolarisation, DNA condensation and cytoskeletal alterations, were evaluated using fluorescence staining assays. Anti-angiogenic efficacy was assessed through the chick chorioallantoic membrane assay and quantitative gene expression analysis for angiogenic markers. Results and Discussion: Characterisation results of NAPTX displayed spherical vesicles with an average size of 36 ± 0.2 nm in SEM analysis, and DLS analysis exhibited a particle size of 69 ± 3.1 nm and 46 ± 6.5 nm in 10 % serum and media, respectively. The FTIR spectra confirmed active incorporation of PTX within the nanoarcheosomes, indicating an efficacious nanoformulation preparation. Furthermore, the MTT assay demonstrated enhanced cytotoxicity in GBM cells, with an IC-50 of 18 ± 2 µM and a corresponding 1.8-fold increase in potency compared with free PTX. Subsequently, fluorescence staining analysis revealed substantial ROS generation, chromatin condensation, mitochondrial membrane depolarisation, and cytoskeletal disruption, indicating apoptotic changes. Moreover, the CAM assay demonstrated significant inhibition of vascular development, indicating a reduction in vessel length, vessel area and junction density. Furthermore, qRT-PCR analysis showed significant downregulation of angiogenic genes VEGFA, FGF2 and ANG1, signifying effective suppression of tumour-associated angiogenesis.

Conclusion: The archaeal lipid-based nanoformulation significantly enhanced the therapeutic efficacy of paclitaxel against glioblastoma. NAPTX induced apoptosis through ROS-mediated mitochondrial dysfunction and significantly ameliorated angiogenesis by downregulating VEGFA, FGF2 and ANG1. The salient outcomes from the present study demonstrate the potential effect of NAPTX as a promising nanotherapeutic platform for glioblastoma treatment and support further preclinical development.

Keywords: Nanoarachaeosmes, Glioblastoma, Paclitaxel, Apoptosis and Angiogenesis.

Engineering Membrane-interactive Lipopolyplexes For Enhanced Endosomal Escape And Functional Sirna Delivery

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Abstract

Cancer remains one of the most fatal diseases worldwide, with its incidence rates increasing every year, necessitating the development of more precise and effective therapeutic strategies. As one of the promising therapeutic approaches, small interfering RNA (siRNA) therapies utilize RNA interference to precisely silence oncogenes, inhibit tumor growth, and overcome drug resistance. However, inefficient intracellular trafficking remains a major challenge for the clinical translation of siRNA therapeutics. Endosomal entrapment severely limits cytosolic release and subsequent gene silencing in the non-viral siRNA delivery systems. In this study, we have formulated aptamer-tethered endosomal membrane-interactive lipopolyplexes designed to facilitate targeted intracellular siRNA delivery by enhancing the endosomal escape while maintaining the favorable attributes for efficient cellular delivery. The aptamer-tethered lipopolyplexes were designed and optimized using a Quality-by-Design strategy employing a Box–Behnken experimental design. The nanoformulation was comprehensively characterized for its physicochemical properties, colloidal stability, and biocompatibility. The targeting efficiency was evaluated using flow cytometry and confocal microscopy in non-small cell lung cancer (NSCLC) cell lines. The functional endosomal escape was assessed using complementary flow cytometry and confocal microscopy analysis. Further, the therapeutic performance of the delivered siRNA was evaluated using quantitative real-time PCR (qRT-PCR), and its functionality was evaluated using cell viability, apoptosis, and caspase activation assays. The optimized lipopolyplexes exhibited favorable physicochemical characteristics for intracellular siRNA delivery and demonstrated colloidal stability. The nanocarriers showed excellent target specificity, siRNA delivery, and biocompatibility in NSCLC and normal cell lines. Mechanistic investigations on endosomal escape elucidated the intracellular trafficking events contributing to the enhanced functional delivery of siRNA. Significant target gene knockdown confirmed the functional delivery of siRNA. Consequently, significant target gene silencing led to pronounced reductions in cell viability, accompanied by enhanced apoptotic cell death, compared with the control formulations. Overall, our work establishes a modified lipopolyplex platform that addresses a critical intracellular barrier in nucleic acid therapeutics. Our proposed strategy provides a transformative approach for improving functional siRNA delivery and advancing the development of next-generation siRNA-based therapeutics.

Keywords: Lipopolyplexes; Endosomal escape; Lung cancer; MUC-1 aptamer; Targeted therapy.

Biomimetic Trilayer Electrospun Nanofibrous Scaffold Incorporating Green-synthesized Bee Pollen Silver Nanoparticles For Angiogenesis And Accelerated Diabetic Wound Healing

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Abstract

Diabetes is a chronic metabolic disorder, associated with persistent inflammation, oxidative stress, impaired angiogenesis, bacterial infection and extracellular matrix (ECM) dysfunction, leading to delay in wound healing and chronic non-healing wounds. Thus, a multifunctional biomimetic trilayer electrospun nanofibrous scaffold was developed with green synthesized silver nanoparticles from the mustard bee pollen (MBPAgNPs) for rapid angiogenesis and diabetic wound repair. The scaffold consisted of a top antimicrobial Polycaprolactone (PCL)/chitosan/MBPAgNP layer, a middle PCL/ Poly vinylalcohol (PVA)/fish collagen/MBPAgNP ECM-mimicking layer and a bottom PVA/gelatin/chitosan pro-angiogenic and hemocompatible layer. Physicochemical characterization demonstrated uniform nanofibrous morphology, favourable crystallinity, thermal stability, hydrophilicity, mechanical properties comparable to native skin, and sustained bioactive release up to 15 days. The introduction of MBPAgNPs along with Chitosan led to strong antibacterial and at optimized low dose, and, when combined with collagen, significantly reduced the intracellular reactive oxygen species in the RAW 246.7 cell line. The in vitro studies showed excellent cytocompatibility, and improved migration and pro-angiogenic potential of the bottom layer was confirmed by the chick chorioallantoic membrane (CAM) assay. In streptozotocin/high-fat diet induced diabetic Sprague-Dawley rats, in vivo evaluation showed significantly accelerated wound closure, increased collagen deposition, ECM remodeling, re-epithelialization, and neovascularization. Molecular validation by immunofluorescence, immunohistochemistry and qRT-PCR revealed that the scaffold attenuated oxidative stress and inflammation by downregulating TNF-α and NLRP3, while promoting VEGF/CD31-mediated angiogenesis, MMP9- and integrin-mediated ECM remodeling and Ki-67-associated cell proliferation to enable rapid tissue regeneration. Moreover, the scaffold demonstrated excellent hemostatic effectiveness in a rat liver hemorrhage model. Altogether, this multifunctional trilayer nanofibrous platform demonstrates the regenerative potential of mustard bee pollen-derived silver nanoparticles and provides a promising translational strategy for the therapy of chronic diabetic wounds.

Keywords: Diabetic wounds, Electrospinning, Nanofibers, Silver nanoparticles, Hemostasis, Angiogenesis, Regenerative nanomedicine

Bioprospecting Potential of Curcuma Amada Roxb. From North East India

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Abstract

A number of spp. of the genus Curcuma has been extensively used as food, spice, colouring agent, cosmetics as well as for therapeutic purposes in traditional or folk medicine, worldwide. Apart from Curcuma longa, the Food Safety and Standards Authority of India (FSSAI) have also approved C. amada, C. aromatica and C. zedoaria for consumption in India. These spp. have been traditionally in India, especially the north east India for various applications.

C. amada, popularly known as Mango Ginger, has a raw mango flavor. It is mainly used in the preparation of pickles, curries, chutneys etc. and also in traditional medicines. It possesses antioxidant, antibacterial, antifungal, anti-inflammatory, platelet aggregation inhibitory, cytotoxicity, antiallergic, hypotriglyceridemic, brine-shrimp lethal, enterokinase inhibitory, CNS depressant and analgesic activities. Although the biological activities of the genus Curcuma are largely attributed by presence Curcuminoids, recently the terpenoids present in the essential oils in some spp. of the genus have been explored. The GCMS analysis of essential oils of various accessions of C. amada showed the presence of α-Pinene, β-Myrcene, β-Pinene, (Z)- β-Ocimene, Curzerenone, Curlone and Zingiberene as the major compounds. The accessions showed presence of β-Myrcene in highest concentration. As per reported literature, β-myrcene possess anxiolytic, antioxidant, anti-ageing, anti-inflammatory and analgesic properties. It is also a popular flavouring and aroma agent (food additive) used in the manufacture of food and beverages. Myrcene is abundant in many plant species, including hops and cannabis. So far, its highest concentration has been reported in hops (70%). Since C. amada is widely used in Indian System of Medicine for stomach ailments, myrcene may be one of the major bioactive compounds. A germplasm with high concentration of myrcene will have good commercial application for producing quality raw material for nutraceutical, food and flavour industry.

Keywords: Curcuma amada, Essential oil, GCMS, , β-myrcene, anxiolytic, antioxidant, anti-ageing, anti-inflammatory and analgesic.

CNT Dry-Printed Electrode for Point-of-Care Electrochemical Glucose Biosensing

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Abstract

Diabetes mellitus is a prevalent metabolic disorder characterized by elevated blood glucose levels and affects millions of people worldwide. Accurate and rapid monitoring of glucose concentration is essential for effective diabetes management and prevention of associated health complications. Although conventional glucose monitoring methods offer reliable and accurate measurements, there is a growing need for sensitive, rapid, and miniaturized electrochemical biosensors that enable convenient, efficient, and potentially point-of-care glucose monitoring. In this study, we developed glucose biosensor based on a platinum nanospheres (PtNSs) modified carbon nanotubes (CNT) dry printed electrode (DPE) for potential point-of-care glucose monitoring. CNT-DPE provided a conductive, high-surface-area platform, while Pt-NSs enhanced electrochemical activity and electron-transfer kinetics. Furthermore, stepwise electrode modification was carried out to construct the enzymatic sensing interface for glucose detection. The sensing performance of the modified CNT-DPE was optimized using cyclic voltammetry and amperometry measurements in 0.1 M PBS (pH 7.4) at different glucose concentrations. The developed CNT-DPE/PtNSs-based biosensor exhibited a rapid, reproducible, sensitive, and stable response toward glucose, demonstrating its potential as a scalable and cost-effective miniaturized platform for point-of-care glucose monitoring.

Keywords: CNT Dry-Printed Electrode, Electrochemical Biosensor, Glucose, Point-of-Care, Voltammetry, Amperometry.

Cationic Pullulan-mos$_2$ Nanocomposite Glass Ionomer Cement for Therapeutic Control of Cariogenic Biofilms

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Abstract

Oral biofilm-associated infections, particularly dental caries and periodontal disease, remain major challenges in oral healthcare and can contribute to broader systemic health complications. Conventional glass ionomer cement (GIC) is widely used in dental and orthopedic applications because of its bioactivity and biocompatibility; however, its limited intrinsic antibacterial activity can compromise its ability to control pathogenic biofilms. Here, we develop a nanomaterial-enabled therapeutic GIC by incorporating cationic pullulan (CP) and two-dimensional molybdenum disulfide (MoS_2) nanosheets to enhance antibacterial and antibiofilm efficacy. Different reinforcement ratios were investigated to identify an optimized formulation with improved antimicrobial performance. The minimum inhibitory concentrations of CP and MoS_2 against Streptococcus mutans were determined to be 2.5 and 40 µg/mL, respectively. Notably, incorporation of only 1% CP resulted in complete bacterial killing. The optimized CP1-$MoS_2$0.1@GIC formulation reduced preformed S. mutans biofilm by more than 93%, demonstrating its potential for therapeutic control of established oral biofilms. Mechanistic investigations revealed extensive bacterial membrane damage and cytoplasmic leakage, accompanied by metabolic arrest. Furthermore, enhanced intracellular reactive oxygen species generation disrupted the bacterial antioxidant defense system, contributing to bacterial inactivation. Collectively, these findings demonstrate that CP-MoS_2 reinforcement transforms GIC into a multifunctional antibacterial nanocomposite with potent activity against established S. mutans biofilms, highlighting its potential as a therapeutic nanomedicine approach for infection control in dental biomaterials.

RNA Sequencing Unmasks a CERK::GTSE1 gene fusion in aggressive Eyelid Sebaceous Gland Carcinoma: A Potential Oncogenic Signature

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Abstract

Sebaceous gland eyelid carcinoma, a rare and aggressively malignant tumour arising generally from meibomian glands, and sometimes from the glands of Zeis, or others associated with the caruncle, is often misdiagnosed as benign eyelid conditions. This frequent misdiagnosis and hindered treatment development are due to limited knowledge of its molecular pathogenesis, stemming from its rarity and limited genomic analysis. This study aimed to identify the novel fusion gene drivers expressed in eyelid sebaceous carcinoma. It approached the analysis using RNA sequencing. The data obtained from RNA extraction, followed by cDNA library preparation and sequencing, were used to detect and identify fusion genes using five independent bioinformatic pipelines (FusionCatcher, Squid, Pizzly, Arriba, and STARfusion). The four patient fusions were compared with the two normal samples to further prioritise the potential sample for target fusion. The selected sample was further analysed to identify potentially cancerous fusions. Two potentially cancerous fusions (RBM47::APBB2 and CERK::GTSE1) were identified. CERK::GTSE1 predicted as an in-frame, oncogenic fusion suggested greater potential for production of a chimeric protein with functional significance than RBM47::APBB2. CERK retained diacylglycerol kinase catalytic domain which phosphorylates diacylglycerol (DAG) to phosphatidic acid (PA), a potent mitogenic lipid. Overexpression of GTSE1 has been associated with poor prognosis, chemoresistance, and metastasis in various carcinomas. The fusion creates a constitutively active kinase by removing CERK's regulatory regions while retaining its catalytic domain. This may lead to uncontrolled phosphatidic acid (PA) production, which triggers mTOR pathway hyperactivation, PI3K-AKT pathway activation, promoting cell survival and inhibiting apoptosis; and sustained proliferative signalling, maintaining cell cycle progression.

Keywords: Sebaceous Carcinoma; Eyelid; RNA-Seq; Gene Fusion; CERK::GTSE1; PI3K-AKT

Stimuli-sensitive, BSA based BBR loaded hybrid nanohydrogel with anti-inflammatory, and antioxidant properties to enhance healing in Diabetic wounds

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Abstract

Diabetic wounds (DWs) are often associated by severe infections, persistent inflammation, and excessive oxidative stress, which alter the wound microenvironment and severely delay healing. Consequently, developing multifunctional wound dressings that simultaneously address these challenges is crucial. In this study, self-healing composite nano-hydrogels were prepared by crosslinking bovine serum albumin (BSA) and berberine (BBR) with Chitosan and phosphatidylcholine (PC) their therapeutic efficacy was evaluated both in vitro and in vivo.

Berberine-loaded phosphatidylcholine-chitosan hybrid nanoparticles (BBR-PC-ChNPs) were engineered via a modified ionic complexation method and dispersed in an aqueous BSA solution to create hydrogels. The mixture was thermally crosslinked at 70–80 °C for 4–5 hours, with incubation time adjusted to control viscosity, before storing at 4 °C. Physical characterization of nanoparticles and hydrogels includes DLS, Zeta potential, TEM, Rheology, Thermogravimetric analysis, XRD, FTIR confirmed the successful nanoparticle encapsulation within the resulting gel matrix.

The results demonstrated that the BSA-BBR-PC-ChNPs nanohydrogel significantly accelerated wound closure in diabetic mice, achieving a healing rate of 97.90 ± 1.81% by day 21. This extraordinary performance is attributed to its multi-targeted biological activities, specifically its antibacterial, anti-inflammatory, and antioxidant properties which collectively established a favourable microenvironment for sequential tissue repair. Quantitatively, nanohydrogels exhibited an antibacterial efficacy exceeding 90% against Escherichia coli and Staphylococcus aureus. Furthermore, it significantly reduced nitric oxide (NO) levels, demonstrating potent anti-inflammatory effects, while maintaining a low haemolysis rate that confirms its excellent biocompatibility. Taken together, these findings suggest that the BSA-BBR-PC-ChNPs nanohydrogel is a highly promising dressing candidate for the clinical management of diabetic wounds.

Keywords: Berberine (BBR), BSA-BBR-PC-ChNPs nanohydrogels, Antibacterial, Anti-inflammatory, Wound closure.

Bioinspired Silver Based Nanozymes For Nir Light Mediated Redox Catalytic Multimodal Theranostics

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Abstract

Breast cancer remains one of the most frequent malignancies and a leading cause of cancer death worldwide. Despite great progress in the diagnosis and treatment of cancer, conventional anticancer therapies are still limited by therapeutic resistance, poor selectivity to tumor cells, systemic toxicity, and tumor heterogeneity. The development of multifunctional nanotherapeutic systems with selective tumor recognition, real-time imaging and simultaneous therapeutic effects is a promising approach toward precision cancer therapy. In this study, we developed folate receptor targeting silver pheophorbide nanozymes (FA-Ph@Ag NZs) as a theranostic nanoplatform for targeted breast cancer therapy and multimodality imaging.

FA-Ph@Ag NZs were designed through the incorporation of silver nanoparticles (AgNPs) with the photosensitizer pheophorbide-a (Ph) and the functionalization of the nanoplatform with folic acid (FA) to allow for receptor-mediated targeting to folate receptor-overexpressing breast cancer cells. The developed nanoparticle showed efficient near-infrared (NIR)-responsive photothermal conversion for localized heat generation upon laser irradiation. Meanwhile, their innate peroxidase-like nanozyme activity facilitated catalytic production of reactive oxygen species (ROS), notably under tumor-simulated acidic and peroxide-abundant microenvironment. This dual photothermal and catalytic activity was engineered to generate a synergistic therapeutic microenvironment to enhance oxidative stress in tumor cells. The targeting potential of FA-Ph@Ag NZs was studied in MDA-MB-231 and 4T1 breast cancer cell lines and normal MCF-10A breast epithelial cells as non-malignant model. To understand the mechanism of cytotoxicity, a number of complementary cellular assays were performed. Moreover, JC-1 mitochondrial membrane potential analysis showed a significant mitochondrial depolarization. To further investigate the theranostic potential of the FA-Ph@Ag NZs, 4T1 tumor-bearing BALB/c mice were used.

In addition, photoacoustic (PA) imaging was used to non-invasively track changes related to the tumor and monitor changes in tumor oxygenation after treatment, demonstrating the potential of this platform for functional tumor imaging beyond the standard fluorescence-based biodistribution assessment.

In conclusion, this work presents FA-Ph@Ag NZs as a multifunctional theranostic nanoplatform combining targeted drug delivery, nanozyme-mediated catalytic therapy, photothermal therapy, fluorescence imaging, and photoacoustic functional imaging into one nanoplatform. The ability of simultaneously promoting tumor-specific accumulation, generating therapeutic heat and ROS, monitoring tumor-associated variations and inhibiting tumor proliferation highlights the promising potential of FA-Ph@Ag NZs as a potent strategy for accurate therapy and multimodal management of breast cancer.

Keywords: Breast cancer, Nanozymes, Photoacoustic imaging, folic acid

Graphene Oxide Nanoformulation Reverses Molecular Alterations Associated with Chemoresistant Colorectal Cancer

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Abstract

Introduction: The mechanisms of chemoresistance in colorectal cancer (CRC) are tightly linked molecular programs of aberrant proliferation, failure of apoptosis, multidrug transport and cellular stress adaptation. The simultaneous targeting of these networks is a significant hurdle for conventional chemotherapy and is a chance for precision nanomedicine. The molecular profile of CRC was explored and it was tested if an aptamer-conjugated, lactoferrin drug loaded graphene oxide (GO) nanoformulation could modulate the chemoresistance associated biomarkers in CRC models including a 5-fluorouracil (5-FU) resistant phenotype.

Methods: The expression level of mRNA for proliferation-associated markers (EpCAM, nucleolin and Myc), apoptotic regulators (caspase-3 and caspase-8, Bax, Bid and Bcl-2), the cell-cycle regulator p21, MIC-1, multidrug-resistance associated transporters (MRP-1, LRP, ABCG2 and ABCB1), and heat shock proteins of the HSPA family (stress-response proteins) were examined in tumor and in adjacent healthy tissues from 30 CRC patients. The molecular effects of the GO nanoformulation were then tested in the Caco-2, HT-29 and 5-FU resistant HT-29 cells as well as HEK-293 cells (cancerous vs. non-cancerous). Treatment with nanoformulation was found to modulate the biomarkers when compared to 5-FU treatment.

Results: CRC tumor tissues exhibited a coordinated molecular phenotype with coordinated upregulation of pro-proliferative markers (EpCAM, nucleolin, myc, Bcl-2 and survivin isoforms) and pro-survival markers (MIC-1 and HSPA-family stress-response proteins) of multidrug-resistance associated transporters. In Caco-2, HT-29 and 5-FU resistant HT-29 cells, the GO nanoformulation was able to cause a wide chemoresistance reversal of this transcriptional profile. Nanotherapeutic treatment resulted in down-regulation of markers of oncogenesis, anti-apoptosis, multidrug-resistance and stress response, and while concurrently up-regulating the pro-apoptotic markers as well as up-regulating the cell-cycle inhibitor, p21. The nanoformulation involved multiple aspects of the 5-FU resistance-associated biomarker network in the 5-FU-resistant cell line, HT-29. GO nanoformulation was shown to be more broadly molecularly regulating the multidrug-resistance associated phenotype than 5-FU with minimal effects on the non-cancerous HEK-293 control.

Keywords: Colorectal cancer, Chemoresistance, Graphene Oxide, Nanomedicine, Targeted drug delivery

Biofabricated Silver Nanoparticles From Centella Asiatica As A Potential Therapeutic Strategy Against Breast Cancer

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Abstract

Breast cancer is one of the leading causes of morbidity and mortality worldwide among women. According to latest WHO report, there were an anticipated 2.4 million new cases of breast cancer in 2024, with 694,000 fatalities, demanding the urgent need for therapies which are safe and effective. Recently, green synthesis of silver nanoparticles using medicinal plants has emerged as environmentally friendly approach for developing novel nanomedicines. In the present study, silver nanoparticles were bio fabricated using aqueous leaf extract of Centella asiatica and characterized using UV-Visible spectroscopy, Dynamic Light Scattering (DLS), Fourier transformed infrared spectroscopy (FTIR) and Scanning electron microscopy (SEM). DLS and SEM analysis revealed predominantly spherical nanoparticles with an average size between 45-62 nm. The anticancer potential of the green synthesised AgNPs was evaluated against breast cancer cell lines (MCF-7, MDA MB 468) and normal cell line (HEK 293). Cytotoxicity was assessed using MTT assay demonstrating potent antiproliferative activity with an IC50 value of 731 ng/mL. The effect of AgNPs on cancer cell migration was investigated using a wound healing assay. Untreated control cells exhibited approximately 80% wound closure whereas AgNP-treated cells showed only 35% wound closure indicating marked suppression of migratory capacity. The cellular uptake assay confirmed efficient internalization of AgNPs by MCF-7 cells, supporting their interaction with intracellular targets. Collectively, these findings demonstrate that Centella asiatica mediated AgNPs embrace significant anticancer activity by enabling cellular internalization, inhibiting breast cancer cell proliferation and migration. The combination of green synthesis, efficient cellular uptake and potent biological activity highlights the potential of these bio fabricated silver nanoparticles as a promising nanomedicine candidate for breast cancer therapy. Further molecular investigations will provide deeper insights into the mechanism underlying their anticancer effects.

Keywords: Green synthesis, silver nanoparticles, Centella asiatica, Anticancer activity, Cellular uptake.

Deciphering Size-dependent Nano-bio Interactions Of Silver Nanoparticles For Development Of Rapid Pathogen Biosensing Platforms

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Abstract

Understanding nano-bio interactions is fundamental to the rational design of nanomaterial-enabled biosensors. Herein, we systematically investigated the impact of silver nanoparticle (AgNP) size (5–100 nm) on the binding affinity, structural integrity, thermodynamics, and catalytic activity of urease, and translated these mechanistic insights into the development of a highly sensitive pathogen biosensing platform. Microscale thermophoresis revealed pronounced size-dependent interactions, with 5 nm AgNPs exhibiting the strongest binding affinity (Kd = 66 nM), accompanied by significant conformational changes confirmed by circular dichroism spectroscopy. In contrast, 20 and 50 nm AgNPs displayed weaker interactions (Kd = 712 and 616 nM) with minimal structural perturbation, whereas 100 nm AgNPs retained strong binding (Kd = 171 nM) while largely preserving the enzyme's secondary structure, indicating inhibition predominantly through steric shielding rather than structural denaturation. Leveraging this understanding, a dual-affinity (antibody and aptamer) functionalized AgNP-urease biosensing platform was developed for rapid and ultrasensitive detection of Salmonella using a turn-on sensing strategy. In the absence of the target pathogen, AgNPs strongly inhibit urease activity through direct nano-bio interactions. Upon specific recognition of Salmonella, the antibody-aptamer complex forms a target-induced shielding layer at the nano–bio interface, preventing AgNP-mediated enzyme inhibition and restoring urease activity, thereby generating a distinct colorimetric signal. The optimized biosensor achieved a limit of detection of 10 cells mL ¹, exhibited excellent specificity against non-target bacteria, and demonstrated reliable performance in real water samples. Collectively, these findings established nanoparticle size as a critical determinant of enzyme inhibition and provided a mechanistic framework for biosensor development using in biomedical and environmental applications.

Keywords: Silver Nanoparticles (AgNPs), Nano-Bio Interactions, Urease, Enzyme Inhibition, Pathogen sensing, Turn on Biosensors.

Hydroxyurea – Cerium oxide nanoconjugate for improved antioxidative therapeutic efficacy in Sickle Cell Anemia

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Abstract

Sickle cell anemia (SCA) a severe monogenic hemoglobinopathy that involves the aggregation of hemoglobin S, hemolysis, vaso-occlusive crises, inflammation, and oxidative stress, all of which result in the progression of cellular and vascular damage. Hydroxyurea (HU) continues to be a key pharmacologic treatment option for SCA in view of its role in inducing HbF and prevention of complications due to sickling, but its efficacy is variable, and HU does not serve to regulate the oxidative microenvironment associated with SCA. Therefore, approaches that can work in conjunction with the effect of HU on disease management in relation to redox regulation could be considered logical.

In this study, the design and synthesis of Hydroxyurea-cerium oxide nanoconjugates (HU-CeO_2 NCs) will be described for their potential applications in the development of a nanotherapeutic platform that combines the pharmacological effects of HU and catalytic antioxidant activities of CeO_2 NPs. Cerium oxide nanoparticles (nanoceria) have redox cycling of Ce^{3+}/Ce^{4+} and oxygen vacancies dependent catalytic activity which allows for superoxide dismutase/catalase-like ROS scavenging. Therefore, it can be anticipated that the proposed HU-CeO_2 NCs will offer a synergistic therapeutic strategy where pharmacologic effects of HU on the sickling process will be combined with nanoceria-mediated antioxidant therapy. Properties of the nanoconjugates will be characterized in terms of physico-chemical and morphological features, drug loading/conjugation efficiency and colloidal stability. Functional characterization of the HU-CeO_2 NCs will include ROS scavenging/antioxidant activity, oxidative stress and other relevant disease parameters in suitable model systems.

Through combination of disease modifying pharmacotherapy and catalytic redox regulation under a unified nanoplatform, HU-CeO2 NC could serve as a scientifically based solution in addressing two linked pathophysiological aspects of SCA, and not just the process of HbS polymerization as is the case with hydroxyurea monotherapy. HU-CeO2 NC could potentially be the basis of designing novel multifunctional nanomedicines which would be able to enhance the therapeutic potential of HU and prevent the oxidative damage that comes with SCA.

Biophotonics to Nanobiophotonics: Evolving Frontiers in Light-Based Medicine

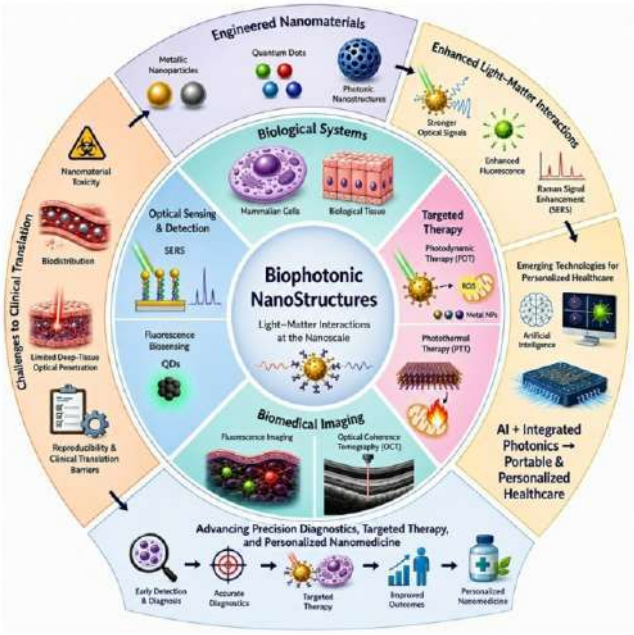
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Abstract

Biophotonics is an interdisciplinary field that utilizes light to investigate, diagnose, and treat biological systems, forming the basis of several advanced imaging, sensing, and therapeutic techniques. However, conventional biophotonic approaches may be limited by weak molecular signals, tissue scattering, limited penetration depth, and insufficient molecular specificity. The integration of nanotechnology with photonics has therefore emerged as a promising approach to address some of these limitations, giving rise to nanobiophotonics at the interface of nanotechnology, photonics, biology, and medicine.

This poster builds upon the existing literature on biophotonics and explores its emerging interface with nanotechnology in the context of biomedical applications. It highlights key developments in optical techniques for diagnosis, imaging, and therapy, and discusses how the incorporation of nanoscale materials and structures can enhance their potential for sensitive, specific, and targeted biomedical applications.



Beyond diagnostics and imaging, the interaction of light with nanomaterials also provides opportunities for targeted therapeutic approaches, including photothermal and photodynamic therapy, enabling localized and minimally invasive treatment. The integration of nanobiophotonics with emerging technologies such as artificial intelligence and integrated photonics further presents opportunities for advanced and personalized healthcare. Despite these advances, challenges including nanomaterial toxicity, biodistribution, limited deep-tissue optical penetration, reproducibility, and clinical translation remain significant. Overall, the literature highlights the potential of combining biophotonics with nanotechnology to advance precision diagnostics, imaging, and targeted therapy, thereby contributing to the broader field of nanomedicine.

Keywords: biophotonics, nanostructures, imaging techniques, diagnostic and therapeutic

Design, Synthesis and Biological Evaluation of Novel Isatin–glyoxamide-1,2,3-triazole Hybrids

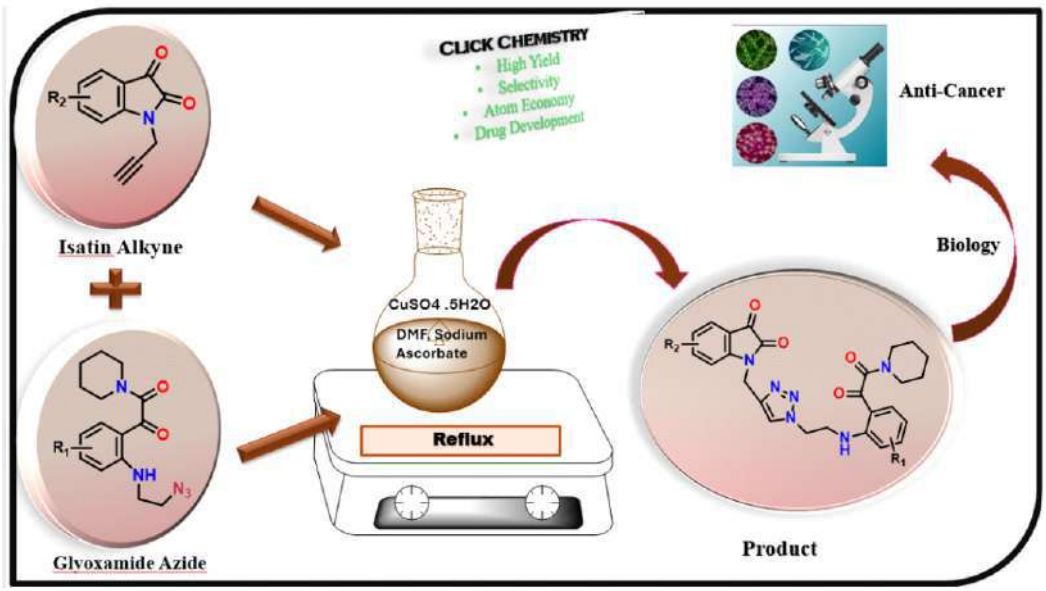
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Abstract

Despite Significant advances in Oncology, Cancer remain one of the major global health concerns which necessitates the continued discovery and development of novel structurally diverse scaffolds for improved treatment strategies. In the present work, we design and synthesized novel class of isatin-glyoxamide-1,2,3-Triazole molecular hybrid through a click reaction between isatin alkyne and glyoxamide azide with the objective of exploring their potential as anticancer agents. The structural design was guided by the known biological relevance and reported anticancer properties of isatin and glyoxamide derivatives. Following structural synthesis and characterization, the final compounds were subjected to biological evaluation against selected human cancer cell lines, namely MCF-7 (breast), A549(lung), HeLa(cervical) and HCT-116(colon). The study highlights the potential of combining complementary pharmacophores through click chemistry to generate novel candidates for further anticancer drug discovery.

Keywords: Glyoxamides, Anticancer agents, Triazole, Click reaction, Isatin, ADMET



Valorisation Of Bos Indicus Excreta Biowaste Into Nanocellulose-reinforced PVA Composite Films for Sustainable Packaging

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Abstract

Agro-livestock nano-composite film enhance bio-degradable polymeric property. Nanocellulose derived from bovine excreta (BNC) offer a promising strategy for sustainable storage and packaging application. as a sustainable route for developing polyvinyl alcohol (PVA)-based bio-nanocomposite films as environmentally friendly alternatives to petroleum-derived plastic packaging. The novelty of this work lies in introducing ruminant-derived cellulose as a distinct class of biologically transformed lignocellulosic material, which differs significantly from conventional plant-derived cellulose. A zero-waste, biologically driven pretreatment pathway involving alkaline delignification followed by sulphuric acid hydrolysis was employed to extract nanocellulose with an average diameter of 15 nm. By using the solvent casting method, these nanocellulose were added to polyvinyl alcohol (PVA) solution at different concentrations (1%, 3%, 5%and 7%). A comprehensive characterization showed that 5% nanocellulose loading greatly improved film properties, the crystallinity index increased from PVA, thermal stability improved with a shift in the maximum degradation temperature and UV barrier properties were significantly improved. Strong hydrogen bonding between PVA hydroxyl groups and nanocellulose was verified by FTIR analysis, which showed peak broadening and O-H stretching band shifting. XRD patterns showed improved crystalline ordering, while SEM imaging showed uniform nanocellulose dispersion with improved interfacial adhesion. The 5% NC-PVA films demonstrated superior mechanical qualities, including a lower rate of water vapour transmission, the capacity to seal heat, and extended nine-day shelf life for sprout samples. By converting livestock waste into useful nanomaterials for biodegradable packaging applications, this study illustrates a sustainable circular economy strategy that tackles the problems of enteric ruminant biowaste waste, plastic waste, and environmental pollution.

Keywords: Nanocellulose; Polyvinyl alcohol; active packaging; and Waste valorization.

Goarang: An Initiative Towards Sustainable Pigment Production

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Abstract

Bovine urine (Gomutra) has held a prominent position in Indian civilisation and traditional medicine for centuries; it is frequently cited in ancient texts for its purported therapeutic and biochemical properties. Beyond its established antimicrobial attributes and organic composition, cow urine contains essential trace elements. This study demonstrates a novel, sustainable synthesis of a blue pigment, i.e GOARANG. This blue pigment is a historically significant coordination complex and industrial pigment. Our research utilised the endogenous metal content of cow urine to produce the same blue pigment sustainably. The synthesis was achieved by treating filtered cow urine with acid, followed by a controlled reaction with a salt solution. A distinct blue precipitate is subsequently produced by slow oxidation. X-ray diffraction (XRD) analysis confirmed that the synthesised pigment possesses crystalline peaks identical to those of commercially available blue pigment used in dyeing industries. To evaluate the viability of an eco-friendly pigment production workflow, Inductively Coupled Plasma Mass Spectrometry (ICP-MS) was performed on the supernatant obtained during the washing stages, while Scanning Electron Microscopy (SEM) was utilised to characterise the particulate morphology and size distribution of the pigment. These findings suggest a viable biogenic route for industrial pigment fabrication, which can be a replacement of indigo by utilising abundant organic byproducts. This innovative pigment can be groundbreaking in tackling dye pollution and can show extra valent results in achieving the same goals as indigo.

Keywords: Cow urine, Blue pigment, Sustainable synthesis, Synthetic dye production, Denim and Dyeing Industry, Characterisation of Pigment

Nano Sentinel: Enhancing Food Security Through Advanced Xoo Biosensing

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Abstract

Xanthomonas oryzae pv. oryzae (Xoo) is a pervasive bacterial pathogen with global implications, causing bacterial blight in rice and threatening food security. Effective management of Xoo diseases in field conditions, protected farm operations, and international borders relies heavily on early detection of Xoo. Traditional detection methods, including immunological assays such as direct tissue blot immunoassays (DTBIA) and enzyme-linked immunosorbent assays (ELISA), as well as molecular techniques like loop-mediated isothermal amplification (LAMP) and polymerase chain reaction (PCR), are commonly employed for pathogen identification. However, these methods often require sophisticated instrumentation and trained personnel, resulting in time-consuming and resource-intensive processes that are unsuitable for on-site analysis. To overcome these challenges, we have developed a sensitive electrochemical biosensor for Xoo detection by exploiting the unique properties of a core nano assembly of gold nanoparticles. The biosensor incorporates a specific DNA probe designed based on the PthXo1 gene, a prominent virulence factor of Xoo. This probe is immobilized on the electrode surface, enabling sequence-specific hybridization and subsequent electrochemical transduction for sensitive and rapid detection of Xoo upto 1fg/µl level. This innovative approach holds promise for monitoring of Xoo, thereby contributing to the development of effective disease management strategies and the preservation of global food security.

Keywords: Biosensors, Plant pathogen, Bacteria, Xanthomonas, Rice, Core-satellite Nano assembly

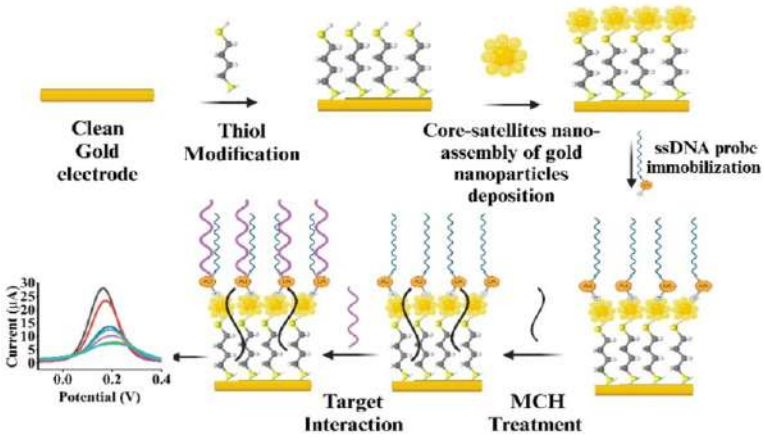


Figure 1: Electrochemical approach for quantitative detection of Xoo

Programmable DNA Nanocages for Next-generation Glioblastoma Therapeutics

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Abstract

Glioblastoma multiforme (GBM), a World Health Organization (WHO) grade IV brain tumor, remains one of the most aggressive and treatment-resistant malignancies. The efficacy of current therapies is significantly limited by extensive intratumoral heterogeneity, frequent recurrence, and the blood–brain barrier (BBB), which restricts efficient drug delivery to the brain. Although temozolomide (TMZ) is the first-line chemotherapeutic agent for GBM treatment, its therapeutic efficacy is often compromised by poor tumor selectivity, systemic toxicity, and the development of chemoresistance. To address these challenges, we developed programmable DNA tetrahedral nanocages (DNA-NCs) as a biocompatible nanocarrier platform for the targeted delivery of TMZ. Furthermore, the DNA-NCs were functionalized with hyaluronic acid (HA) to generate HA@TMZ-DNA-NCs, enabling CD44 receptor-mediated targeting of glioblastoma cells, which overexpress CD44 on their surface.

The engineered HA@TMZ-DNA-NCs exhibited uniform nanoscale dimensions, a well-defined tetrahedral architecture, high structural stability, and efficient drug encapsulation. In vitro studies using U87MG and LN229 glioblastoma cell lines demonstrated significantly enhanced cellular uptake and anticancer activity of HA@TMZ-DNA-NCs compared with free TMZ, as confirmed by confocal microscopy and cell viability assays. Furthermore, evaluation in a three-dimensional GBM spheroid model revealed superior tumor penetration and more pronounced inhibition of spheroid growth and viability following treatment with HA@TMZ-DNA-NCs, highlighting their enhanced therapeutic efficacy in a physiologically relevant tumor microenvironment. Collectively, these findings establish programmable DNA tetrahedral nanocages as a versatile, biocompatible, and highly adaptable platform for targeted drug delivery in glioblastoma. This work underscores the potential of DNA nanotechnology to overcome current therapeutic barriers and facilitate the development of next-generation precision nanomedicines for GBM and other challenging brain malignancies.

Keywords: Glioblastoma, Temozolomide, DNA nanocages, Targeted cancer therapy

Intranasal Delivery Of Sertraline Hydrochloride Enhanced Brain Concentration And Antidepressant Action: A Promising Strategy For Major Depressive Disorder

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Abstract

Major depressive disorder (MDD) remains a leading cause of disability worldwide, while oral sertraline hydrochloride therapy is constrained by poor aqueous solubility, extensive first-pass metabolism, and limited oral bioavailability; thus, its brain availability is determined by hepatic metabolism and systemic exposure. In this regard, intranasal nanocarriers offer a promising strategy to enhance direct brain delivery.This study comparatively evaluated PEGylated solid-lipid nanoparticles (SLNs) and poly(lactic-co-glycolic acid) (PLGA) nanoparticles as intranasal carriers for sertraline hydrochloride.

Methods: Optimized PEGylated lipidic and polymeric nanoparticles were developed and evaluated for physicochemical characteristics, in vitro drug release, ex vivo nasal permeation, nasal mucosal safety, pharmacokinetics, and antidepressant efficacy in preclinical models.

Results: SLNs (153.43 nm; encapsulation efficiency 88.64%) and PLGA nanoparticles (174.60 nm; encapsulation efficiency 86.64%) exhibited nanoscale particle size, high drug loading, enhanced nasal permeation, and acceptable mucosal safety. While SLNs provided sustained drug release, PLGA nanoparticles displayed comparatively faster release kinetics. Intranasal administration markedly increased brain delivery over oral administration, with maximum brain concentrations increasing from 21.67 ng/g to 322 ng/g (SLNs) and 1096 ng/g (PLGA nanoparticles), and brain exposure (AUC) increasing from 515.62 to 5489 and 14362 ng·g ^{1}·h, respectively. Despite achieving lower brain exposure than PLGA nanoparticles, SLNs produced a marginally greater antidepressant response, suggesting that sustained drug release may contribute more to therapeutic efficacy than peak brain drug concentration alone.

Conclusion: Compared with the oral route, both PEGylated lipidic and polymeric nanoparticles substantially enhanced brain delivery and antidepressant efficacy upon intranasal administration, providing clinical translational potential for the treatment of major depression.

Isolation, Characterization And Pharmaceutical Potential Of Plant-derived Nanocellulose For Solubility Enhancement Of Poorly Soluble Drugs

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Abstract

The growing number of poorly water-soluble drug candidates in today's pharmaceutical development poses a significant challenge for ensuring good dissolution, bioavailability, and therapeutic effectiveness. In this situation, nanocellulose has shown promise as a natural nanomaterial because of its biodegradability, biocompatibility, renewable source, high surface area, and varied surface chemistry. The present work focusses on the isolation of nanocellulose from plant-based biomass and assessing its potential as a pharmaceutical excipient to improve the solubility and dissolution behavior of poorly soluble drugs.

Plant-derived nanocellulose was isolated using appropriate pretreatment and hydrolysis methods. It was then characterized with physicochemical techniques to ensure its nanoscale size, structural integrity, crystallinity, and surface functional groups. Researchers examined the isolated nanocellulose as a carrier system for poorly soluble drugs, aiming to improve drug wettability, dispersion, and dissolution. The improved surface interactions between nanocellulose and drug molecules should help increase water solubility and bioavailability, while also reducing problems linked to drug recrystallization.

The study shows that nanocellulose plays multiple roles in developing pharmaceutical formulations. It also reveals its potential as a sustainable and effective option for drug delivery. In addition to improving solubility, plant-based nanocellulose opens up possibilities for new dosage forms such as solid dispersions, nanocomposites, hydrogels, and controlled-release systems. These findings support the increasing interest in nanocellulose-based pharmaceutical technologies and lay the groundwork for future research on using sustainable nanomaterials in next-generation drug delivery systems.

Keywords: Nanocellulose, Plant-Derived Biomaterials, Solubility Enhancement, Drug Delivery, Bioavailability, Solid Dispersion, Poorly Soluble Drugs.

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Deciphering The Role Of Green-synthesized Nanoparticles From Opuntia-ficus Indica To Enhance Red Blood Cell Membrane Integrity: A Novel Therapeutic Approach To Hemolytic Anemia.

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Abstract

The membrane of a red blood cell (RBC), or erythrocyte, constitutes a dynamic and fluid structure characterized by elasticity and strength, which are essential for surviving up to 120 days within the circulatory system.[1] Its lipid bilayer predominantly comprises phospholipids and cholesterol, with integral proteins distributed throughout the membrane and a membrane skeleton located on the cytoplasmic side.[2] The band-3 complex is centered around the band-3 tetramer; however, band-3 can also exist as a dimer. Each band-3 monomer features a broad transmembrane segment with a long, branched polylactose aminoglycan on the non-cytoplasmic side and a stalk-like cytoplasmic domain that binds to ankyrin-1. Ankyrin-1 connects to both the C-terminal end of the β-spectrin chain and protein 4.2.[3-5] Numerous inherited disorders of red blood cells result from alterations in the membrane, including hemolytic anemia (HA), such as hereditary spherocytosis (HS), hereditary elliptocytosis (HE), hereditary ovalocytosis (SAO), and hereditary stomatocytosis. Opuntia ficus indica (OFI), commonly known as prickly pear, is extensively utilized in traditional medicine to treat hematological conditions such as low hemoglobin (Hb) levels and reduced red blood cell counts. Using an In-silico workflow combining network pharmacology, molecular docking, and molecular dynamics, we identified Isorhamnetin and L-DOPA as principal phytochemical components capable of stabilizing RBC membrane integrity. To optimize delivery, green nanoparticles were synthesized from OFI extract and evaluated In-vitro. The nano-formulations demonstrated efficient cellular internalization and significant surface-level protection against lipid peroxidation. Furthermore, functional assays in HepG2 cells revealed that the nanoparticle-phytochemical system successfully mobilized erythropoietin (EPO) expression, while displaying highly favorable safety profiles and low cytotoxicity against HeLa and RPE1 cell lines. Taken together, these results demonstrate that OFI-derived nano-systems protect membrane architecture and stimulate erythropoietic pathways, offering a promising, biocompatible strategy for the management of hereditary hemolytic anemias. Future In-vivo studies are warranted to validate these protective mechanisms in physiological models.

Keywords: Green-synthesized Nanoparticle, Hemolytic Anemia, Membrane Integrity, Opuntia-ficus indica, Red Blood Cell.

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Neurological Sequelae Of Vector Vs Mrna-based Covid-19 Vaccines: A Systematic Review

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Abstract

The widespread deployment of COVID-19 vaccines has markedly reduced severe disease and mortality worldwide. However, rare neurological complications following vaccination have raised questions about potential differences in safety between vaccine platforms. This study explores: Do vector-based COVID-19 vaccines pose a higher risk of neurological complications compared with mRNA-based vaccines? Addressing this question helps improve understanding of vaccine safety and inform post-vaccination monitoring.

Methods: A systematic review of observational studies was conducted using PubMed, Scopus, Web of Science, Google Scholar, and Medline up to January 14, 2025. Studies involving adults (≥18 years) reporting neurological symptoms after receiving ChAdOx1 nCoV-19, Ad26.COV2.S, BNT162b2, or mRNA-1273 were included. Independent variables were vaccine platform and type; dependent variables were neurological outcomes, including Guillain-Barré syndrome (GBS), seizures, and cerebral venous sinus thrombosis (CVST). Study quality was assessed using the Newcastle-Ottawa Scale.

Results: Eleven studies met the inclusion criteria, representing diverse populations and study designs. Severe neurological events were rare across all vaccines. Vector-based vaccines were more frequently associated with GBS, CVST, and seizures than mRNA vaccines. ChAdOx1 nCoV-19 showed the strongest link with GBS, while Ad26.COV2.S was associated with higher seizure risk, particularly in women under 50. mRNA vaccines were mostly associated with mild, short-term effects, such as headaches and facial paralysis, with rates comparable to those in the general population.

Discussion: Vector-based vaccines may trigger immune-mediated neurological effects, possibly through molecular mimicry. In comparison, mRNA vaccines show a more favourable neurological safety profile.

Conclusion: Severe neurological complications after COVID-19 vaccination remain rare. Continued pharmacovigilance and broader, diverse population studies are essential for refining risk estimates and sustaining public confidence in vaccination programs.

Keywords: Covid-19 vaccines, Neurological adverse events, Vaccine pharmacovigilance

The Skyline Of Artificial Intelligence And The Horizon Of Nanomedicine

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Abstract

The title of this abstract is not a metaphor to captivate the attention of the reader. However, it is a precursor. What the human eye witnesses becomes science. However, what about the science that already exists in the universe and enters our cellular systems through the science of our eyes? The abstract undoubtedly scientific be traversed from ideation and transformation till translation through the use of figures of speech for a scientific reason, that is, the metaphors that we operate by. Advancements in the technology we use every jiffy of a second have exponentially increased the integration of technology into medicine at the nanoscale, which is generically termed nanomedicine. The same book on nanomedicine, and let us re-examine the science so far with two lenses: intrinsic and extrinsic. Turning the pages, the conventional story of nanomedicine, that is, with the intrinsic lens and then the new science with the extrinsic lens, brings the star line title down to earth. Thus, culminating our experiment in recalibrating the lens to shed light on the dynamic field of artificial intelligence in nanomedicine through our eyes. A second glance at the traditional way artificial intelligence in medicine is perceived reveals that it can achieve a range of outcomes, such as optimizing the material properties of nanoparticles, automating physical synthesis, enabling stimuli-responsive release, bypassing the blood-brain barrier, and targeting drug delivery, among others. However, the central focus of our research is to highlight the frequencies of silence related to perceptions of artificial intelligence in nanomedicine. Technology will always operate in a dual paradigm, but the science will always be coherent, even at the horizon, and that is what we explore through this research. Sophisticated engineering has led to the development of nanoparticles that, in a real sense, mimic the properties of medicines as they enter the bloodstream at the cellular level, with targeted repercussions at the system level. The human intellect has ventured into such depths that the medical purpose of humanity is viable through artificial intelligence in nanomedicine. The research being conducted in this domain is spectacular from a humanitarian perspective. However, then, can we ask the question, "Nanomedicine has repurposed the system or the universe that the human body respectfully is in its own right, what about how the cellular basis perceives the universe from the outside at a nano scale?" This research article will now delve into newer science through an extrinsic lens. The nature that we live in itself is an encyclopedia, or rather, it is an entire universe. The way human eyes perceive this universe and how intelligence transforms, at a cellular level, into knowledge synthesis is a process worth exploring. In this realm of science, answers will be found to the question of how artificial intelligence is changing us at a cellular level. A question whose answer will change many allied fields, including nanomedicine, psychiatry, cybernetics, and neuroscience. If the human mind can comprehend the extent to which artificial intelligence in nanomedicine can be harnessed, the same brain can also assimilate the range of results that understanding artificial intelligence in nanomedicine through an extrinsic lens can take us to. The skyline of artificial intelligence is not that far from the horizon of nanomedicine, provided it witnesses the right-angle split in the starline of artificial intelligence. Thus, recalibrating the horizon of artificial intelligence in nanomedicine through the science of the human eye.

Keywords: artificial intelligence, nanomedicine, technology, nanotechnology, medicine, science.

Novel eco-friendly fluorescent carbon Quantum Dots from the cow urine and coffee grounds for the sensing application

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Abstract

Preventative nanomedicine increasingly relies on the real-time detection of trace environmental toxins, such as heavy metal ions and hazardous gases, which present significant risks to human respiratory and physiological health. Carbon Quantum Dots (CQDs) offer a highly tunable, biocompatible platform for solid-state optical and chemical sensing. The Carbon quantum dots still have a challenge of uniformity at scale, scalable fabrication Balancing the sensitivity. Here, we present a rapid green synthesis of multi-element co-doped CQDs (co-doped with N, K, Cl, Mg, and Na majorly the N and O doped) using a single-step microwave method from organic precursors (cow urine and coffee grounds, which both are the natural source for the Nitrogen and different other elements and minerals). Structural, surface, and optical properties were thoroughly evaluated using UV-Vis, Photoluminescence (PL), FTIR, XPS, XRD, and HRTEM along with the Thermal stability (TGA) and two-month long PL & photostability and transmission revealing a Unique UV blocking properties. Solid-state sensing layers were fabricated on glass substrates via drop-casting techniques, with careful optimization of sub-micron film morphology, colloidal dispersibility, and surface pre-treatment to regulate desiccation kinetics and mitigate edge-assembly limitations. The resulting unpurified CQDs exhibited strong excitation-dependent photoluminescence under near-ultraviolet excitation (~330 nm), revealing specific bandgap and crystal-lattice effects on their optical transitions. The rich multi-element surface chemistry facilitated rapid target interaction. Thin films demonstrated high optical stability and distinct target-dependent response signatures (such as fluorescence quenching) when exposed to varying environmental conditions, highlighting their capability as multi-signal optical sensors for water and air quality monitoring. This work provides an accessible paradigm for developing highly responsive, radiation-resilient, and sustainable CQD-based sensor payloads. By bridging green nanotechnology with robust thin-film engineering, these platforms show immense potential as dual-use sensors for tracking health-threatening pollutants, paving the way for low-power preventative diagnostic devices. This synthesized CQDs can be leveraged to build a resilient Sensor for the astronaut's health and space habitats.

Keywords: Carbon Quantum Dots, Photoluminescence, XRD, UV shielding.

NIR-I/II-Responsive Niosomes Co-Encapsulating Plasmonic Gold Nanorods and IR1061 for Phototherapeutic Ablation of Cancer Cells

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Abstract

Near-infrared (NIR) light-responsive nanomaterials have emerged as powerful tools for cancer therapy, yet stable and biocompatible delivery of NIR-II agents remains a major challenge. In this work, we develop NIR-I/II-responsive niosomes co-encapsulating plasmonic gold nanorods (GNRs) and the NIR-II dye, IR1061, forming a multifunctional nanoplatform for effective phototherapeutic ablation of cancer cells. The niosomal system provides robust encapsulation, improved dispersion stability, and biocompatibility for both photoactive components. Upon NIR-I/II laser irradiation, the nanoplatform exhibits strong photothermal heating and substantial reactive oxygen species generation due to the synergistic integration of plasmonic GNRs and dye-mediated effects. In vitro evaluations demonstrate efficient cellular uptake, potent photoinduced cytotoxicity, and minimal dark toxicity. The integration of photothermal and photodynamic mechanisms results in markedly enhanced therapeutic efficacy compared with individual agents. This study highlights the potential of niosomes as versatile and efficient nanocarriers for dual NIR-window phototherapy, offering a promising route for precise and minimally invasive cancer treatment.

Keywords: Biological Window, Gold nanorods, Near Infrared, Niosomes, Phototherapy

In Silico Drug Discovery For Pancreatic Ductal Adenocarcinoma: Molecular Docking Of Potential Therapeutic Compounds

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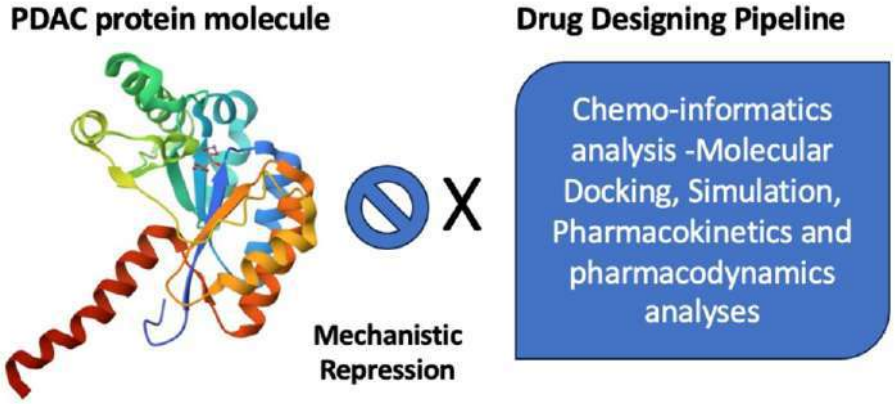
Abstract

Pancreatic ductal adenocarcinoma (PDAC) is the most prevalent and aggressive form of pancreatic cancer, characterized by poor prognosis, early metastasis, and resistance to conventional therapies, resulting in a five-year survival rate below 15%. The high prevalence of mutations in KRAS, along with dysregulation of signalling proteins such as EGFR, PI3K, AKT, and PARP1, has made these molecules attractive therapeutic targets. This study employs an integrated *in silico* drug discovery approach to identify potential inhibitors against key proteins involved in PDAC progression.

Three-dimensional structures of selected target proteins, including KRAS, EGFR, and PARP1, were retrieved from the Protein Data Bank and screened against a library of bioactive compounds using structure-based virtual screening and molecular docking. Binding affinity, interaction profiles, and ligand–protein stability will be evaluated through hydrogen-bond analysis, binding energy calculations, and molecular interaction studies. The top-ranked compounds will be further assessed for drug-likeness, pharmacokinetic properties, and toxicity using Lipinski's Rule of Five and ADMET prediction. Additionally, binding free-energy analysis will be employed to validate the stability and binding strength of the selected protein–ligand complexes under physiological conditions.

This computational workflow provides a rapid and cost-effective platform for lead identification, significantly reducing the time and resources required during early-stage drug discovery. The identified candidates offer promising leads for subsequent *in vitro* and in vivo validation and may contribute to the development of targeted therapies for pancreatic ductal adenocarcinoma.
Depicting the mechanistic pipeline of drug designing.

Keywords: Pancreatic cancer, Molecular designing, In silico analysis, Pharmacological analysis



From Nanoparticle Engineering To Colon-specific Therapy: A Polysaccharide Based Dual-design System For Targeted Apremilast Delivery In Inflammatory Bowel Disease

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Abstract

Inflammatory bowel disease (IBD) is a chronic inflammatory disorder in which conventional oral therapy may suffer from poor solubility, premature absorption, enzymatic degradation, and systemic side effects. This study developed an apremilast-loaded poly(lactic-co-glycolic acid) (PLGA) nanoparticle system incorporated into okra polysaccharide-based pellets for targeted colonic delivery. Apremilast was selected for its anti-inflammatory activity and poor aqueous solubility. PLGA nanoparticles were prepared using the solvent evaporation method and optimized through response surface methodology. The optimized formulation showed 88.7% entrapment efficiency and 9.85% drug loading, with spherical and smooth morphology. Okra polysaccharide was extracted and incorporated into pellets containing the optimized nanoparticles, followed by Eudragit S-100 coating to provide pH-dependent protection and preferential release in the colon. The combined system integrates nanoscale controlled drug release with natural polysaccharide-based colon targeting. Overall, the developed formulation offers a promising approach for improving localized apremilast delivery and potentially reducing systemic adverse effects in the management of IBD.

Keywords: PolymericNanomedicine, PLGA Nanoparticles, Apremilas,t Colon-Specific Drug Delivery,Inflammatory Bowel Disease

Dual-targeted Wzb117–metformin Nanoparticles for Metabolic Therapy of Breast Cancer

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Abstract

Breast cancer cells obtain energy via glycolysis, a process known as the Warburg effect. Targeting this altered glucose metabolism is a promising therapy, which is driven by increased GLUT1 for glucose uptake, AMPK activation, and decreased mTOR. These assist in the advancement of cancer.

Metformin (MET) has anticancer properties; i.e., it activates AMPK and inhibits mTOR, but its effectiveness is limited by short residence time, rapid elimination, and the amount of glucose available at the tumour site. To overcome this, researchers developed a dual-targeted nanoparticle system in which the O-carboxymethyl chitosan (OCMC) carriers are pH-responsive. OCMC releases the drug preferentially in an acidic microenvironment. The system contains both MET and WZB117, a GLUT1 inhibitor that reduces glucose uptake by cancer cells. The nanoparticles were prepared by ionic gelation with a uniform size of 225.67 ± 11.5 nm, a low polydispersity index (0.113 ± 0.16), and a high encapsulation efficiency (72.78 ± 6.4%). MET showed pH-dependent release under acidic conditions, and the conjugation of WZB117 to OCMC was confirmed by FTIR and mass spectrometry.

In MCF-7 and MDA-MB-231 cells, WZB117-OCMC-MET nanoparticles showed greater cytotoxicity, cellular uptake, more apoptosis, and DNA fragmentation, including stronger G0–G1 cell-cycle arrest than with MET or OCMC-MET alone. Their higher selectivity for cancer cells over normal MCF-10A cells confirms lower toxicity to healthy tissue. The mechanism of WZB117-OCMC-MET nanoparticles involved the activation of AMPK and the suppression of mTOR and BCL2 to trigger cancer cell death. This makes them a promising metabolic approach for the treatment of breast cancer.

Keywords: breast cancer metabolism; metformin; WZB117; conjugation; Nanoparticle; O-Carboxymethyl chitosan

Dual Targeted Antibacterial Activity Of A Graphene Oxide-nitrofurantoin (go@nf) Nanohybrid Via Membrane Disruption And Redox Imbalance

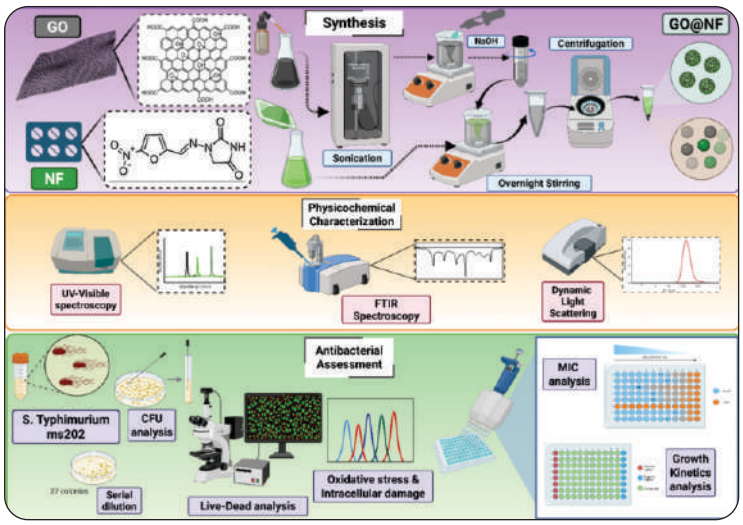
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Abstract

The increase in prevalence of multidrug-resistant bacterial infections has enhanced the efficacy of current antibiotics while concurrently targeting several bacterial defense systems urgently needed. In this study, a graphene oxide-nitrofurantoin (GO@NF) nanohybrid was produced and characterized using UV-Visible spectroscopy, dynamic light scattering (DLS), and FTIR spectroscopy. Its antibacterial potential against Salmonella enterica serovar Typhimurium ms202 was then assessed. In order to determine the potential mechanisms underlying the GO@NF nanohybrid's increased activity, a variety of microbiological, fluorescence-based, flow cytometric, and computational techniques were used to compare its antibacterial effectiveness with pristine graphene oxide (GO).

Antibacterial activity assessed using colony-forming unit assays, growth kinetics, time-dependent death studies, and minimum inhibitory concentration measurements. GO@NF continuously outperformed GO alone in both inhibitory and bactericidal responses throughout these trials. Bacterial viability gradually declined with increasing nanohybrid concentrations, as evidenced by lower recoverable colony numbers and optical density. These findings suggested that combining nitrofurantoin (NF) with GO significantly enhanced the system's overall antibacterial efficacy. Oxidative stress and intracellular damage measured using acridine orange and dihydroethidium-based assays. Compared to GO, GO@NF treatment increased the production of reactive oxygen species (ROS) and nucleic acid-associated damage, indicating the oxidative stress plays a significant role in its antibacterial activity.



All these findings point to the dual mode mechanism of action for GO@NF that includes both intracellular oxidative stress generation and physical membrane rupture. When compared to GO alone, this combination results in increased antibacterial efficacy. According to our research, GO@NF is a powerful nanohybrid with great potential to fight bacteria that are resistant to antibiotics.

Keywords: Salmonella enterica serovar Typhimurium ms202; Antimicrobial agents; Graphene oxide; Nitrofurantoin; GO@NF nanohybrid; Membrane Disruption; Oxidative Stress

Influence of Milling Parameters on Crystal Morphology, Thermal Behaviour, and Dissolution of Mesalamine Nanocrystals

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Abstract

Background: Advances in drug discovery have led to the development of numerous hydrophobic molecules that present significant solubility challenges. Under the Biopharmaceutics Classification System (BCS), such compounds are categorised as Class II or IV, characterised by low solubility with high or low permeability, respectively. Particle-size reduction is a promising strategy for enhancing wettability, increasing effective surface area, and improving dissolution, thereby potentially increasing drug exposure and bioavailability. Mesalamine (MES), a primary therapeutic agent for inflammatory bowel diseases, exhibits low aqueous solubility and incomplete dissolution in the colon, necessitating a high administered dose of up to 4.8 g/day.

Objective: This study aimed to investigate the effects of dry ball-milling parameters on the crystal morphology, particle size, solid-state properties, and dissolution behaviour of mesalamine nanocrystals, and to identify suitable processing conditions to improve their pharmaceutical performance.

Methods: MES nanocrystals were prepared using a dry ball-milling approach with Soluplus® as a stabiliser. Milling parameters, including milling time, milling speed, and stabiliser concentration, were investigated and optimised to obtain desirable particle size and pharmaceutical attributes. The prepared nanocrystals were characterised using scanning electron microscopy, particle-size analysis, spectroscopic techniques, thermal analysis, and dissolution studies to evaluate the influence of processing conditions on their physicochemical and pharmaceutical properties.

Results: Stabiliser concentration and milling conditions significantly influenced the characteristics of the prepared nanocrystals. Increasing the Soluplus® concentration from 1 to 10% w/w resulted in aggregate formation, which may be attributed to increased thermal energy generated during milling. Scanning electron microscopy revealed diverse crystal morphologies, including rectangular bars, elongated hexagons, spheroids, and plates, demonstrating a clear relationship between processing parameters and crystal habit. Among the investigated batches, Batch 29 (40/1/400) exhibited a plate-like crystal habit, a particle size of 435 nm, and a polydispersity index of 0.39. This batch demonstrated improved dissolution efficiency, with approximately 84% of mesalamine dissolved within 60 min. Spectroscopic, microscopic, and thermal characterisation further confirmed the influence of ball milling on particle size, crystal morphology, and solid-state properties.

Keywords: crystal habit · dissolution enhancement · mesalamine · milling · nanocrystals · process optimization

Mechanical Alloying-induced Structural And Thermal Evolution of A Mg-zn-ca Alloy For Nanostructured Biodegradable Orthopaedic Applications

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Abstract

Magnesium (Mg) based alloys are potential candidates for biodegradable orthopaedic implants due to their biodegradability, light weight nature and compatibility with bone tissues. However, the use of such materials depends on the alloy's structural and degradation properties, which can be tailored through material processing. Mechanical alloying offers an efficient way, through repetitive deformation, fracture, and refinement, to modify the microstructural properties of magnesium-based alloys.

In this work, we investigate the effect of mechanical alloying on the structural, morphological, and thermal properties of Mg–Zn–Ca alloy for possible biodegradable orthopaedic applications. Elemental powder mixtures of Mg, Zn and Ca were subjected to high-energy planetary ball milling at 10:1 ball-to-powder ratio by means of stainless-steel vials and stainless-steel balls. 0 hour and 20 hour milled samples were characterized using scanning electron microscopy (SEM), X-ray diffraction (XRD) and differential scanning calorimetry coupled with thermogravimetric and derivative thermogravimetric analysis (DSC/TG/DTG). The effects of prolonged milling on the morphology, crystal structure, and thermal behaviour were evaluated through the obtained characterisation data. XRD results of 20 hour milled sample display peak broadening and reduction in intensity relating to crystallite refinement and increased micro strain caused by severe plastic deformation during ball milling. Additional peaks of the second phase appear in the 20-hour milled sample. SEM results of 20-hour sample support fine fragments which is typical for prolonged milling. Different temperature and mass-change events were identified by DSC/TG/DTG analysis. For the 20-hour sample, the high-temperature event showed a noticeable change while the main DTG event did not change significantly.

The findings show that after 20 hours of milling, mechanical alloying process significantly alters the morphological, structural, and thermal characteristics of the Mg–Zn–Ca alloy while maintaining mostly crystalline structure. Retained crystalline structure is advantageous for maintaining load bearing capacity while crystallite refinement and secondary phases can enable controlled degradation. Thus, this work has implications for further investigation of Mg–Zn–Ca alloys as potential candidate for biodegradable orthopaedic applications.

Keywords: Magnesium; mechanical alloying; ball milling; biodegradable implants

Reverse engineering of branded mesalamine prolonged release pellets for synthesis of QTPP and FMEA: A systematic approach for oral complex generic product development

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Abstract

Generic drug products are central to global healthcare, providing affordable and accessible therapies across diverse populations. Their prescription rate is nearly 90% in North America and Europe, while in countries such as Japan and India, generics account for about 50% of prescriptions. In India and Russia, branded generics dominate clinical practice. Despite their widespread use, generic products often face criticism regarding safety, efficacy, and interchangeability. Developers must demonstrate bioequivalence with branded formulations, ensuring equivalent release rates, therapeutic response, and stability throughout shelf life, while also navigating complex intellectual property landscapes.These challenges are particularly pronounced in complex generics, which include formulations with difficult active ingredients, specialised delivery routes, intricate dosage forms, and drug-device combinations. Mesalamine prolonged-release granules (PRGs, Pentasa™) exemplify such complexity. Classified as a BCS Class IV drug (low solubility, low permeability), mesalamine products exhibit high variability, making bioequivalence difficult to establish. This study presents a systematic reverse engineering (RE) protocol for Pentasa™ PRGs. Three different reference-listed drug (RLD) lots were analyzed using a wide range of advanced techniques: UV spectroscopy, moisture content using water activity and IR moisture balance, High Performance Liquid Chromatography - Reverse Phase (HPLC) for assay, Fourier-Transform Infrared spectroscopy (FT-IR), Raman Spectroscopy-532 nm (RS-532), Proton Nuclear Magnetic Resonance Spectroscopy - 500 MHz (NMR) for drug excipient compatibility/interaction studies, Optical and Scanning Electron Microscopy (SEM) for surface morphology, Raman Chemical Imaging (RCI) and Focal Plane Array-FTIR (FPA-FTIR) chemical imaging for drug and excipient distribution in intact granules, surface area and porosity by BET, thermal analysis by DSC, crystallinity using PXRD, metallic impurities using LC Inductively Coupled Plasma Mass Spectrometry (LC ICP-MS) and particle size by laser diffraction, Head Space Gas Chromatography-Mass spectrometry (HS GC-MS) for residual solvents, size exclusion chromatography for molecular weight determination of PVP and ethyl cellulose, texture analysis for deformation studies, packaging evaluation, and in vitro multimedia dissolution using validated USP method. The RE of PRGs provided critical insights into the structural and functional design of complex oral drug delivery systems. Analytical characterisation revealed the role of excipients, coating systems, and microstructural attributes in achieving time-dependent release and therapeutic consistency. Key findings included: Thin ethyl cellulose (EC) coating as the rate-controlling polymer, Polyvinylpyrrolidone (PVP) as binder, High drug loading with uniform batch-to-batch consistency, Stable particle size distribution, release profile, assay, and content uniformity, Controlled moisture content and water activity, Absence of residual solvents and metallic impurities. Mapping these findings into a structured Quality Target Product Profile (QTPP) provided a scientifically grounded framework for generic product development. The defined QTPP emphasised critical quality attributes (CQAs) such as particle size distribution, release profile, coating thickness, binder level, water activity, and mechanical strength, all directly linked to patient outcomes.

Controlling Diabetic Retinopathy Through Novel Vegf-targeted Aptamer Tethered Pazopanib Nano Therapy

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Abstract

Diabetes is a primary global health concern, affecting more than 9% of the population worldwide, representing around 12% of global health expenditure. And one of the long-term consequences of diabetes is Diabetic Retinopathy. It is a microvascular complication of diabetes mellitus, characterized by damage to the small blood vessels in the retina due to chronic hyperglycemia. Over time, high glucose levels can lead to vascular occlusion, increased vascular permeability, and neovascularization, ultimately causing retinal ischemia, hemorrhages, and fibrosis. Untargeted approaches have their benefits as well as limitations. Therefore, to address these limitations, we hereby introduce a target-specific approach to eliminate the effects of Diabetic Retinopathy by delivering Pazopanib via VEGF aptamer-tagged HSA nanoparticles to the targeted site. Pazopanib (PZP) is a multi-targeted tyrosine kinase inhibitor (TKI) that inhibits VEGF receptors and other kinases, thereby impeding the signaling pathways that promote angiogenesis and vascular permeability. The nanoformulation was prepared using the desolvation method and tagged with VEGF aptamer via the EDC-NHS mechanism, verified by Agarose Gel Electrophoresis. Furthermore, DLS, CD, XRD, TEM, and FTIR were used to characterize the nanoformulation. Stability assessments, including in vitro release, cellular uptake, and efficacy studies, were evaluated using the MTT assay. A diabetic cell model was established by treating cells with glucose concentrations ranging from 5.5 mM to 150 mM. To evaluate the therapeutic efficacy of Apt-PZP@HSANP, MTT and ROS assays were subsequently performed. Specific molecular markers were checked in response to the treatment under high-glucose conditions. These markers were further analyzed to determine their relationships using IP, ChIP, and phosphorylation assays. Cell migration was evaluated using a scratch assay, and a tube formation assay under treatment conditions was performed to assess intercellular connectivity. The mitochondrial membrane potential and apoptosis assays confirmed the therapeutic effect of the Apt-PZP@HSANP in ARPE-19 cells. In vivo studies are underway to assess the therapeutic potential of Apt-PZP@HSANP in a disease-relevant model.

Keywords: Diabetic Retinopathy, HSA nanoparticle, Pazopanib, V7t1 Aptamer

AI-Augmented Computational Method: Deciphering the p53-Modulatory Landscape of Crude Phytochemical Matrices via High-Throughput Metabolomic Mining

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Abstract

The clinical reactivation of the tumor suppressor protein p53 is hindered by the challenge of identifying potent, druggable ligands within the vast chemical space of crude phytochemical extracts. Navigating this complexity requires an intelligent, automated computational framework capable of converting high-resolution LC-MS metabolomic data into validated therapeutic leads.

Objective: This research introduces an AI-augmented pipeline designed to perform high-throughput mining of large-scale natural product libraries (4,271 entries across dual-ionization modes) to identify high-affinity p53-targeting scaffolds.

Methods: We deployed an integrated workflow beginning with the automated prioritization of phytochemicals based on spectral significance (AUC and m/z values). These candidates were processed through high-throughput inverse molecular docking protocols against the p53 receptor (PDB ID: pdb_00004xr8). The pipeline further employed artificial intelligence-based predictive modeling (Swiss ADME) to perform "intelligent filtering" of the chemical space, utilizing BOILED-Egg analysis to optimize for bioavailability, blood-brain barrier permeability, and drug-likeness.

Results: The system successfully identified potential candidates from plant extract, with Cauferoside (-11.0 kcal/mol) and FF-MAS (-10.9 kcal/mol) exhibiting superior binding affinities. Computational structural analysis revealed precise π-alkyl and hydrogen-bonding interactions within the p53 binding domain, while cross-analysis via ADMET intelligence models validated compounds like Paravallarine and HETERONEMIN as structurally robust leads.

Conclusion: This study establishes a scalable, AI-ready framework that bridges the gap between raw analytical metabolomics and intelligent drug discovery. Ongoing efforts include the expansion of our docking library to encompass the remaining structural dataset, complemented by forthcoming Molecular Dynamics (MD) simulations to further elucidate the stability and binding kinetics of our premier hits.

Keywords: High-Throughput Metabolomic Mining, AI-augmented pipeline , Molecular Dynamics simulations

Nano Biosensor And Devices For The Detection of Heavy Metals

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Abstract

In the present scenario, the accumulation of heavy metal (such as lead (Pb), mercury (Hg), cadmium (Cd), arsenic (As), and chromium (Cr)) and its related pollution is a global concern which degrade the environment as well as human health at a large scale. The detection of heavy metals ion is not easy as they cause a serious impact on plants, animals, humans, and ecosystems. Various analytical techniques such as atomic absorption spectroscopy (AAS), inductively coupled plasma mass spectrometry (ICP-MS), and high-performance liquid chromatography (HPLC) have been employed for the detection of heavy metals ions but the problem with these techniques is its expensive nature. Therefore, recent advances shifted toward nanotechnology that permitted the development of nano biosensor and other medical devices which can detect heavy metal ions very quickly and sensitively. A biosensor is an analytical tool that integrates a biological component capable of recognizing specific substances and a device which converts the biological response into a signal and give information about the substrate concentration. Nano biosensors utilize nanomaterials such as gold nanoparticles, silver nanoparticles, graphene, carbon nanotubes, quantum dots, and magnetic nanoparticles to enhance signal transduction, selectivity, and detection limits.

Incorporation of biological recognition elements with nanomaterials create a highly selective biosensing platforms for the detection of heavy metal ions. Additionally, wearable sensors, lab-on-a-chip systems, and smartphone-integrated biosensors have gain attention due to portable and real-time diagnosis of heavy metal ions. These technologies provide rapid screening of biological fluids, drinking water, food samples, and environmental matrices while reducing analysis time and operational costs. Therefore, the objective of this research is to highlights the recent advances in nano biosensors and devices for the detection of heavy metal along with future applications.

Keywords: Nano-Biosensor, Heavy Metals, Atomic Absorption Spectroscopy, wearable sensors.

Nanopharmaceutical Approaches To Overcome Poor Oral Bioavailability: Current Strategies And Translational Challenges

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Abstract

Oral administration remains the preferred route of drug delivery; however, poor aqueous solubility, limited dissolution, chemical instability, and extensive first-pass metabolism can markedly reduce the bioavailability of therapeutic agents. Nanopharmaceutics offers a promising strategy to address these limitations by engineering drug carriers at the nanoscale with enhanced physicochemical and biological properties. This review examines approaches for improving oral drug bioavailability using nanostructured delivery systems, with emphasis on lipid-based nanoparticles, nanostructured lipid carriers, liposomes, polymeric nanoparticles, nanoemulsions, and other nanoscale formulations. The mechanisms through which these systems enhance drug performance—including improved apparent solubility, protection against gastrointestinal degradation, increased dissolution and membrane permeation, lymphatic transport, and controlled drug release—are considered. The potential of surface modification and rational formulation design to improve stability and facilitate site-specific delivery is also discussed. Despite encouraging advances, translation of nanopharmaceutical systems from laboratory research to clinical application remains challenging because of formulation complexity, particle-size variability, scale-up, physical stability, reproducibility, characterization requirements, toxicity concerns, and regulatory standardization. A successful nanopharmaceutical product therefore requires an integrated understanding of formulation science, pharmacokinetics, biocompatibility, and manufacturing quality. Overall, nanotechnology can provide a versatile platform for transforming poorly bioavailable drug candidates into more effective oral therapies, but continued emphasis on standardized characterization, safety assessment, scalable manufacturing, and clinically meaningful outcomes is essential for successful bench-to-bedside translation.

Keywords: Nanopharmaceutics; Oral Drug Delivery; Nanoparticles; Bioavailability; Nanomedicine; Lipid-Based Nanoparticles; Drug Delivery

Hypoxia-induced Modulation Of Cellular And In Vivo Uptake Of Dna Nanocages – Implications In Therapeutics

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Abstract

DNA tetrahedra (DNA Td) are promising nanocarriers for drug delivery, but how hypoxia affects their cellular internalisation remains poorly understood. We synthesised and characterised Cy5-labelled DNA Td and established chemical hypoxia using 100 μM CoCl in HeLa, MDA-MB-231, and MCF-7 cells. Hypoxia was confirmed by HIF-1α nuclear translocation with >92% cell viability. Confocal microscopy revealed significantly reduced DNA Td uptake under hypoxia ($P < 0.01$), whereas transferrin and cholera toxin B uptake increased, indicating cargo-selective regulation. Temperature-arrest experiments confirmed reduced energy-dependent internalisation. Pharmacological profiling showed a shift from clathrin-mediated (42% 29%) and galectin/glycan-dependent (43% 35%) pathways toward lipid raft/cholesterol-dependent uptake (36% 56%). Hypoxia increased plasma membrane electronegativity and altered cortical actin organisation, suggesting a biophysical barrier to DNA Td uptake. Importantly, DOTMA complexation restored uptake to normoxic levels, identifying electrostatic repulsion as a key determinant. In zebrafish larvae, hypoxia significantly enhanced whole-larva DNA Td accumulation ($P < 0.001$). These findings highlight surface charge engineering as a strategy for improving DNA nanostructure delivery under hypoxic conditions.

Keywords: DNA nanotechnology, DNA Tetrahedron, Hypoxia, cell uptake

Unravelling The Dynamics Of Spinal Cord Injury Via Non-invasive Photoacoustic Imaging And Therapeutic Modulators

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Abstract

With few available treatments, spinal cord injury (SCI) and the neurodegenerative processes that accompany it cause severe disabilities. Spinal cord injury (SCI) is a serious neurological disorder with complex pathophysiological pathways that frequently causes irreversible motor and sensory deficits. The most common results after SCI include endothelial damage, astrogliosis, microgliosis, and neuronal degeneration. Researchers are currently concentrating more on the sophisticated instruments for imaging the many physiological and pathological aspects of the spinal cord. Two-photon imaging, light sheet fluorescence microscopy, in vivo imaging systems using fluorescent probes, and in vivo chemical and fluorescent protein-expressing viral tracers are some of the instruments. In a number of areas, including optical tissue sectioning, 3D reconstructed imaging, and imaging of specific planes of interest, these methods surpass the drawbacks of traditional methods. However, they have several drawbacks, including poor tissue penetration, variable labeling efficacy, clearing-induced distortion and fluorescence quenching, and invasive surgical access. So, to develop a nanotheranostic platform for assessing the pathophysiology of spinal cord injury is deemed to be necessary. In this work, we synthesize and assess Pheophorbide-a conjugated zinc oxide nanoflakes (Phei-Zn NFs) as a nanotheranostic platform in conjunction with near-infrared (NIR) photobiomodulation (PBM) therapy for the treatment of SCI. When examined in vitro models, the Phei-Zn NFs showed photothermal stability, neuronal cell uptake, antioxidant, and anti-inflammatory qualities. Following treatment with Phei-Zn NFs in conjunction with NIR light-based PBM therapy, additional mechanistic research revealed an upregulation of regenerative indicators and a downregulation of inflammatory biomarkers. Concomitantly, we have also incorporated the use of photoacoustic imaging, a novel method for elucidating the pathobiology after experiment SCI in rats. As a new technique for identifying and monitoring the different pathological reactions in real time, we have employed and introduced PA imaging as an important tool to establish association with the injury pathology. This non-invasive imaging technique can be helpful in identifying the main pathophysiological processes, such as ischemia, hypoxia, oxygen saturation, and hemoglobin levels, which can be better suited for developing more effective treatment strategies at various damage stages. Furthermore, to determine the therapeutic efficacy, the application of Phei-Zn NFs has been evaluated in compression model in rats. Non-invasive photoacoustic imaging revealed that the Phei-Zn NFs improved micro-CT contrast imaging and increased vascularization in the in vivo rat SCI model. Molecular analyzes demonstrated better blood-spinal cord barrier integrity, anti-inflammatory microglial polarization, and inhibition of pro-inflammatory cytokines. These results demonstrate the potential of Phei-Zn NFs in conjunction with photobiomodulation treatment (PBMT) as a noninvasive approach to reduce inflammation, encourage neuroregeneration, and enhance functional outcomes following SCI. Therefore, our developed nanotherapeutic agent (Phei-Zn NFs) can be effective in mitigating neuroinflammation and reduce hypoxia and ischemia after SCI, rendering better behavioural outcomes after SCI.

Keywords: Spinal cord injury, Phei-Zn nanoflakes, Photoacoustic imaging, hypoxia, neuroinflammation

Lipid-ctpp Conjugated Nanocarriers For Targeted Drug Delivery In Glioblastoma: In-vitro And In-vivo Effects

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Abstract

Glioblastoma multiforme (GBM) has emerged as a challenge to treat primarily because of its hostile nature and complex pathophysiology. Although, Temozolomide (TMZ) is primary chemotherapeutic agent but its efficacy is limited by poor solubility, restricted BBB permeation, systemic toxicity, and drug resistance. Henceforth, nanomicelles (PMCs)based delivery systems offer a promising approach to overcome these limitations by enhancing mitochondrial targeting, cellular uptake, and therapeutic efficacy of TMZ in brain. In this study, we focused on developing TMZ-loaded nanomicelles (TMZ-TSPC PMCs) for targeted GBM therapy.

Methods: CTPP (3-(Carboxypropyl)triphenyl phosphonium bromide), a mitochondrial-targeting agent, was conjugated to hydrogenated phosphatidylcholine (Lipoid SPC-3) via Steglich esterification. Synthesized TSPC conjugate was characterized, purified and lyophilized. Blank and TMZ-loaded nanomicelles (TSPC PMCs and TMZ-TSPC PMCs) were prepared using ultrasonication method.

Results: CTPP was employed as a targeting ligand to enhance TMZ brain delivery. Particle size distribution of developed formulations (TSPC PMCs and TMZ-TSPC PMCs) was determined to be 314.1 ± 50.3 and 218.6 ± 18.12 nm, respectively, while morphological features were determined by FESEM. In-vitro drug release of TMZ-TSPC PMCs in acidic pH (PBS pH 4.0) was observed to be approx. 96.19 ± 2.33 % in 24 h while at physiological pH (PBS pH 7.4) TMZ underwent hydrolysis into its active metabolite, MTIC. In-vitro anti-proliferative activity of TMZ-TSPC PMCs resulted in almost double values than pure TMZ (p value < 0.0001). Intracellular ROS levels exhibited significant elevation than control accompanied by stronger depolarized mitochondrial membrane, leading to ROS-induced mitochondrial apoptosis. In correlation to cell line studies, in-vivo studies were performed on Sprague-Dawley rats. As a result, it was observed that plasma half-life (t1/2) and bioavailability (AUC (0 to ∞)) of TMZ-TSPC PMCs were improved in comparison to pure TMZ by 1.21 and 1.53 folds ($p < 0.0001$), respectively. Study demonstrated robust anticancer efficacy of TMZ-TSPC PMCs against U87MG and LN229 cells. Therefore, CTPP conjugated nanocarriers could be a promising targeting agent for delivery of therapeutic moieties (TMZ) against GBM.

Conclusion: Lipid–CTPP conjugates were successfully synthesized, characterized and utilized to formulate TMZ-loaded micellar nanoconstructs. Our research demonstrated TMZ-TSPC PMCs as a potent anticancer activity against U87MG and LN229 cells. Developed TMZ-TSPC PMCs exhibits high entrapment efficiency, enhanced mitochondrial targeting, improved pharmacokinetic and enhanced brain uptake with minimal toxicity.

Potential Natural Inhibitors of SARS-CoV-2 M^{pro}: Biochemical Screening and Stability Assessment

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Abstract

This study's goal is to use a combination of biochemical, biophysical, thermodynamic, and in silico techniques to examine the inhibitory potential of phytochemicals, in particular Phytochemicals, against the SARS-CoV-2 main protease (Mpro).

Methods: The interaction between phytochemicals and SARS-CoV-2 Mpro was examined, and its inhibitory potential and binding properties were evaluated, using a combination of biochemical assays, fluorescence and circular dichroism (CD) spectroscopy, isothermal titration calorimetry (ITC), and molecular modelling, aggregation study includes SEM microscopy and florescence microscopy.

Result: Current study employed biochemical, biophysical, thermodynamic, as well as in silico methods to examine the potential of phytochemicals resulting into the discovery of phytochemicals as a potential inhibitor of Mpro. Using a stoichiometric binding site (n) of one and a Ka 6.2387 x 104 M−1 for sinigrin and 3.4215 x 104 M−1 for eugenol, 3.3868 x 104 for stigmasterol and 3.124 x 104 for Scopoletin. the fluorescence spectroscopy revealed that phytochemicals was actively quenching the Mpro. Measurements of synchronous fluorescence spectra revealed substantial alterations in the microenvironment surrounding tryptophan residues in the presence of phytochemicals, while CD-spectroscopy demonstrated prominent changes in the helical content. The findings of molecular modelling research and measurements using isothermal titration calorimetry (ITC) supported the spectroscopic data and shed light on their thermodynamic properties. Interestingly, eugenol exhibits significantly higher binding than the positive control-quercetin to Mpro, resulting in structural disruption and inhibition with an IC50 of 2.81 uM, and rest of the phytochemicals showing

Conclusion: In conclusion, Scopoletin, Eugenol, sinigrin and stigmasterol shows strong potential as an inhibitor of SARS-CoV-2 Mpro, exhibiting higher binding affinity and greater inhibitory effects compared to the positive control quercetin, making it a promising candidate for further development as an antiviral agent against COVID-19.

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Keywords: Antivirals, Biophysical, Biochemical activity.

Herb Mediated Nanoscale Transformation of Bhasma: Deciphering The Role Of Herbal Media In Bhasma Processing

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Abstract

Background: Bhasma are distinctive Ayurvedic pharmaceutical preparations consisting of finely processed powders of metals and minerals, prepared through a sequence of pharmaceutical processes including purification (Shodhana), wet trituration (Bhavana) and controlled thermal treatment (Marana), and traditionally indicated for the management of a wide range of diseases. Ayurveda pharmaceutics (Rasashastra) describes Bhasma preparations derived from metals such as gold, silver, iron, copper, zinc etc, minerals such as mica and chalcopyrite, as well as marine-derived materials including coral and conch shell, with diverse reported therapeutic applications. The complex physicochemical transformations occurring during Bhasma preparation have attracted increasing scientific interest, particularly because several Bhasma preparations exhibit micro- to nanoscale characteristics. However, these characteristics are formulation and process dependent and the mechanisms underlying their formation remain incompletely understood. A distinctive feature of Bhasma preparation is the repeated use of herbal juices, decoctions and other biological media during processing. The contribution of these herbal media to the transformation, surface modification and biological behaviour of Bhasma, however, remains insufficiently understood. This study explores the potential role of herbs as active processing agents in the nanoscale transformation of Bhasma and examines their implications from the perspective of modern nanopharmaceutics.

Materials and Methods: A comprehensive literature review was undertaken to identify classical and contemporary evidence concerning the use of herbal media in Bhasma preparation. Classical Ayurvedic texts were examined to identify Bhasma formulations, the herbs or herbal preparations employed as Bhavana media, and the rationale or therapeutic context associated with their selection. Contemporary literature was searched using PubMed, Scopus, Web of Science and Google Scholar for studies investigating physicochemical, chemical, structural, nanoscale or biological changes associated with herbal-mediated processing of Bhasma and related herbo-mineral preparations. Particular emphasis was placed on evidence concerning particle-size reduction, phase transformation, elemental modification, surface chemistry and interactions between phytoconstituents and metal/mineral components.

Results: The review identified diverse herbal media, including Aloe barbadensis, Citrus limon and polyherbal preparations such as Triphala, used during the processing of different metals and minerals. Although classical texts generally describe the selection of these media in pharmaceutical and therapeutic contexts rather than in terms of molecular mechanisms, contemporary evidence suggests that repeated wet trituration may contribute to particle-size reduction and modification of the physicochemical characteristics of the processed material. Phytoconstituents such as phenolics, flavonoids, organic acids and other biomolecules may participate in metal–phytochemical interactions through adsorption, complexation, reduction–oxidation and surface functionalization. Depending on the material and processing conditions, such interactions may influence phase composition, oxidation state, formation of salts or hydroxide species, elemental incorporation and surface characteristics. Herbal constituents may additionally act as reducing, stabilizing or capping agents, raising the possibility of biologically mediated formation and stabilization of nanoscale domains. The subsequent thermal processing may further consolidate these transformations, producing complex bio-organometallic interfaces. These physicochemical modifications may influence dissolution, bioaccessibility, cellular interactions and ultimately the biological behaviour of the finished Bhasma.

Keywords: Bhavana, Marana, Organometallics, particle size reduction, Rasashastra

Defense In Disguise : Biodistribution And Toxicity Profiling Of Rbc Membrane-camouflaged Nanoparticles For Cancer Theranostics

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Abstract

Near-infrared responsive biomimetic nanoconstructs have gained attention for theranostic applications in oncology owing to their "self-like" properties. A strategic framework comprising nanoparticle characterization, in vitro validation and in vivo pharmacokinetic, biodistribution and toxicity profiling is essential to probe their translational potential. Though similar particles have been mainly studied in tumor models to assess targeting efficiency, their evaluation in healthy subjects remains vital in the preclinical development. Building on our parallel studies using human red blood cells (RBC) based nanoparticles with combinatorial therapeutic effects in cancer cells and spheroid models, we developed murine RBC membrane-camouflaged nanoparticles (mPIC@E NPs) and validated their in vivo biodistribution profiles relative to the uncamouflaged nanoparticles (PIC Nps).

Method: We present RBC membrane-camouflaged PLGA nanoparticles coloaded with FDA-approved indocyanine green (ICG) and cisplatin (mPIC@E NPs). RBCs isolated from blood collected from healthy Swiss albino mice was processed to make the nanoparticles that were administered intravenously to the recipient mice. Murine fibroblasts (NIH-3T3) and macrophages (RAW 264.7) were used to assess the biocompatibility and macrophage uptake of mPIC@E NPs, respectively. Following injection of free ICG, PIC NPs and mPIC@E NPs, animals were euthanized at specific time points till 48 hours. Fluorescence analysis of blood and extracted organs was performed to quantitatively assess the circulation of the nanoparticles. Acute toxicity was evaluated through histological, blood and serum analysis.

Results: TEM confirmed a uniform spherical core-shell morphology with an encircling membrane of ~5 nm around the PLGA nanoparticle. The particles were of ~260 nm with a PDI of 0.1 indicating a monodispersed population. A shift in the charge from -5 mV (PIC NPs) to ~ -12 mV (mPIC@E NPs) further confirmed the membrane coating. Live dead assay of fibroblasts revealed preserved cellular morphology upon treatment with mPIC@E NPs relative to PIC NPs suggesting advantageous properties of the camouflaged system. Macrophages demonstrated higher uptake of PIC NPs (~3.07 fold) compared to mPIC@E NPs (~1.92 fold) at 24 h in contrast to untreated cells.

Conclusion: Our findings showed that the RBC camouflage enhanced the biological attributes of coloaded PLGA nanoparticles, that are critical for effective in vivo performance. Ongoing biodistribution studies in mice comparing the mPIC@E and PIC NPs will further delineate the translational potential of this biomimetic nanoplatform for cancer theranostics.

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Keywords: biomimetic nanoparticles, drug delivery, translational nanomedicine, theranostics, cancer

Predictive Modeling of Sleep Architecture And Cognitive States Using A Wearable Eeg System And Lifestyle Correlation

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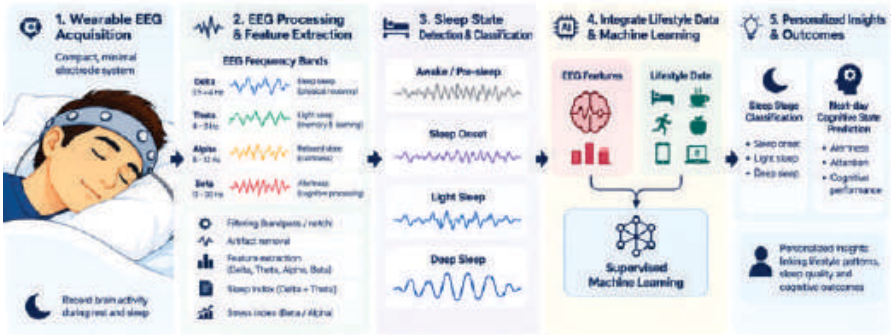
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Abstract

Sleep disorders and chronic sleep deprivation are an escalating problem among students and young adults, silently eroding next-day concentration, memory and long-term health. A recent systematic review estimates global insomnia prevalence at 16.2% (~852 million adults, 7.9% severe) and screening of 17,172 Indian university students reported a prevalence as high as 42.9%. However, much of this burden goes untracked because no affordable platform can continuously link objective brain activity with everyday lifestyle behaviour outside a laboratory. Polysomnography, the clinical gold standard, records EEG, EOG and EMG for detailed sleep staging with an accuracy no portable alternative fully matches, but it falls short in two critical ways: recordings are costly and intrusive and confined to single-night laboratory sessions that rule out convenient longitudinal, at-home monitoring. Lighter alternatives close only part of this gap: commercial fitness wearables infer sleep indirectly from heart-rate and movement data rather than cortical activity, giving variable agreement with true sleep stages, while consumer-grade EEG headbands that do capture direct brain signals lock that data inside closed, proprietary ecosystems with no raw-data access and no integration with a person's daily habits.

Our work proposes an open, three-channel dry-electrode wearable EEG system (design and fabrication in progress) built around an 24-bit acquisition chain and microcontroller that logs Delta, Theta, Alpha and Beta band activity offline overnight and derives a Sleep Index (Delta+Theta) and a Stress Index (Beta/Alpha) directly from the raw signal, independent of any closed processing pipeline. Building on this, the platform pairs these neurophysiological indices with a structured daily log of screen time, lifestyle pattern, stress and menstrual-cycle status inside a supervised machine-learning model, moving from isolated signal acquisition toward genuine sleep-lifestyle correlation and next-day cognitive-state prediction. In conclusion, this work aims to deliver an accessible, low cost and reproducible wearable EEG platform that fills a clear gap between clinical-grade accuracy and everyday usability, laying the foundation for personalized, data-driven sleep and cognitive-health monitoring in young adults.

Keywords: Wearable EEG, Sleep Architecture, Cognitive State Prediction, Machine Learning, Lifestyle Correlation, Sleep Staging, Digital Health Monitoring



Wearable EEG system for sleep-state monitoring and lifestyle integration.

Amyloid-reinforced Hyaluronic Acid Composite Hydrogel Enabling Controlled Curcumin Delivery, Antibiofilm Photothermal Therapy and Accelerated Diabetic Wound Healing

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Abstract

Chronic diabetic wounds are characterized by persistent oxidative stress, impaired angiogenesis, and biofilm-associated infections, necessitating multifunctional biomaterials capable of modulating the wound microenvironment. Herein, we report an amyloid-reinforced hyaluronic acid (HA) composite hydrogel that integrates mechanical robustness, controlled drug delivery, and bioactive functionality within a single platform. The hydrogel is constructed through interpenetrating protein–polysaccharide networks, where thermally induced bovine serum albumin amyloid fibrils act as reinforcing scaffolds within the HA matrix via hydrogen bonding and chain entanglement. This architecture enhances viscoelastic properties, swelling behavior, and structural stability compared to non-reinforced systems. Curcumin is incorporated as a multifunctional therapeutic agent, exhibiting sustained and pH-responsive release governed by hydrophobic and π–π interactions within the composite network. The hydrogel demonstrates pronounced antibacterial and antibiofilm activity against both Gram-positive and Gram-negative bacteria, which is further amplified under near-infrared (NIR) irradiation via photothermal effects. In vitro studies confirm excellent cytocompatibility, hemocompatibility, and enhanced fibroblast migration, indicating favorable cellular interactions. Importantly, in a streptozotocin-induced diabetic wound model, the composite hydrogel significantly accelerates wound closure, promotes collagen deposition and neovascularization, and restores oxidative stress biomarkers toward physiological levels. Mechanistically, the synergistic integration of amyloid-mediated mechanical reinforcement, HA-driven bioactivity, and curcumin-enabled therapeutic functionality enables simultaneous regulation of infection, inflammation, and tissue regeneration. This study establishes a protein–polysaccharide hybrid hydrogel platform that couples structural reinforcement with stimuli-responsive therapeutic delivery, offering a promising strategy for advanced diabetic wound management and translational biomaterial design.

Keywords: Hyaluronic acid; Composite hydrogel; Polysaccharide–protein interactions; Diabetic wound healing; Antibiofilm materials

Development and Optimization of Hesperidin-loaded Nanoemulsion for Enhanced Osteogenic Potential

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Abstract

Hesperidin is a citrus-derived flavonoid that has been reported to possess antioxidant, anti-inflammatory, and osteogenic properties. However, its poor aqueous solubility and limited bioavailability can affect its delivery and therapeutic potential. Nanoemulsion-based delivery systems offer a promising approach to overcome these limitations. The present study is therefore proposed to develop and optimize a hesperidin-loaded nanoemulsion (HES-NE) to improve the delivery of hesperidin and investigate its potential for osteogenic applications. The nanoemulsion will be prepared using suitable oil, surfactant, and co-surfactant components through spontaneous emulsification followed by ultrasonication. Formulation variables will be optimized using a Box–Behnken design to obtain a formulation with desirable characteristics. The prepared nanoemulsions will be evaluated for droplet size, polydispersity index, zeta potential, encapsulation efficiency, and in-vitro drug release. The optimized formulation will also be assessed for its physicochemical characteristics and stability under selected storage conditions. The osteogenic potential of the optimized HES-NE will subsequently be evaluated using an appropriate osteoblast-like cell line.

Cell viability, alkaline phosphatase (ALP) activity, calcium deposition, and selected osteogenic markers, including Runx2, ALPL, and OCN, will be studied to assess the effect of the formulation on osteoblast differentiation. The nanoemulsion is expected to improve the dispersibility and formulation performance of hesperidin and may enhance its cellular delivery and osteogenic potential compared with the free hesperidin. Overall, the study aims to establish a systematic formulation and optimization approach for hesperidin delivery and provide preliminary evidence for its potential application in bone-related nanomedicine and regenerative research.

Keywords: Hesperidin; Nanoemulsion; Osteogenic potential; Box–Behnken design; Bone regeneration

Algan/gan Hemt Biosensors for Multiplexed Physiological Monitoring in High-altitude Military Environments

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Abstract

Soldiers deployed at high altitudes with extreme environmental/climatic conditions face serious health risks like hypoxic stress, dehydration driven thrombosis and early kidney strain that several times remain undetected until symptoms become severe, largely because no compact sensing platform can continuously and reliably track multiple physiological markers together in that extreme environment. AlGaN/GaN High electron mobility transistors (HEMTs) offering their wide bandgap gives them high chemical and thermal stability and biocompatibility that conventional silicon based sensors cannot match, allowing them to operate reliably in direct contact with biological fluids without degrading, making them inherently better suited to harsh, prolonged field, but current HEMT biosensors fall short in two critical ways: their readings drift over time without a bulky reference electrode to stabilize them, and existing designs sense only one biomarker at a time, making them not feasible for real world multi-parameter health monitoring. Our work proposes a AlGaN/GaN HEMT architecture (fabrication and testing in progress) that pairs a functionalized sensing gate with a passivated reference gate on the same device, cancelling drift directly at the sensor level, combined with a lightweight machine learning calibration model that continuously corrects for any remaining baseline shift during field use. Building on this, the platform is designed to test and detect a targeted panel of biomarkers glucose, blood urea, hematocrit, and vital ions chosen for their established relevance to altitude-driven physiological decompensation, moving the platform from single analyte sensing toward true multiplexed diagnostics on a single chip. In conclusion, this work aims to deliver a drift free, multiplexed, and field ready AlGaN/GaN HEMT biosensing platform that fills a clear gap in current military healthcare technology and lays the foundation for a flagship diagnostic healthcare system for soldier health monitoring at high altitude.

3D Printable/injectable Personalized Amyloid Genic Hydrogel For Accelerated Wound Healing And Tissue Regeneration

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Abstract

Personalized biomaterials with multifunctional healing capabilities are essential for addressing complex and diverse tissue injuries. In this work, we present a novel 3D printable and injectable amyloidogenic hydrogel, derived from self-assembling protein fibrils, designed to accelerate healing in renal abscesses, internal organ injuries, deep muscle wounds, and burn wounds. The hydrogel mimics the extracellular matrix (ECM), forming a biocompatible, structurally stable scaffold that supports cell survival, proliferation, and migration. Unlike conventional hydrogels limited by weak mechanical properties, high cost, and poor reproducibility, our hybrid formulation offers enhanced mechanical resilience, scaffold stability, and cost-effectiveness while maintaining high biodegradability and biocompatibility. Tunable porosity and adhesive properties further support cellular infiltration and integration. Inherent antimicrobial, antioxidant, and anti-inflammatory properties facilitate faster tissue regeneration through neovascularization and collagen remodeling. The dual-mode delivery injectable for internal applications like kidney abscesses and printable for surface wounds ensures versatility and site-specific adaptation. In vivo studies on rat models confirm the hydrogel's effectiveness in reducing inflammation, enhancing tissue integration, and significantly accelerating healing outcomes in both soft and complex tissues. This personalized, ECM-inspired hydrogel system addresses current limitations in tissue engineering and wound management, offering a promising, patient-adaptable solution for acute and chronic injuries. It represents a transformative platform in regenerative medicine, capable of meeting the multifaceted demands of modern wound care through its multifunctional healing capabilities.

Keywords: Diabetic wound healing, self-assembly, amyloid fibrils, hyaluronic acid, infection control, 3D printing.

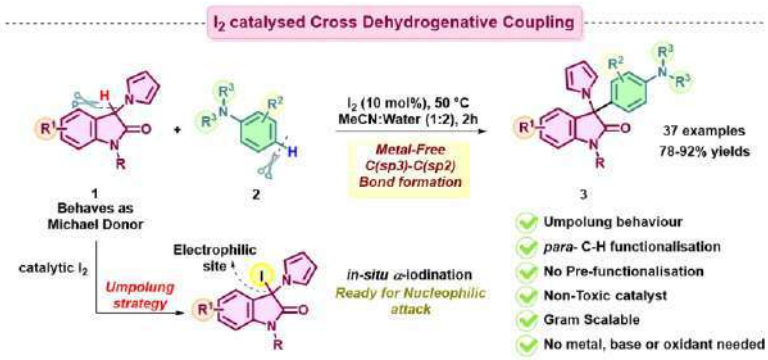
Harnessing Umpolung Reactivity Of 3-pyrrolyl Oxindoles: Iodine-Catalysed Cross-dehydrogenative Coupling For The Direct Synthesis Of 3,3-disubstituted Oxindoles

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Abstract

3-Pyrrol-1-yloxindoles are conventionally recognized as nucleophilic Michael donors, with their reactive C3 center predominantly engaged with electrophilic reaction partners. We herein demonstrate an umpolung strategy that reverses the inherent polarity of the C3 position, enabling 3-pyrrol-1-yloxindoles to participate as electrophilic partners in C–C bond formation. Molecular iodine catalyzes the α-iodination of these substrates to generate a transient C3-iodinated intermediate, which undergoes para-selective C–H functionalization with electron-rich N, N'-dialkylanilines. This transformation provides direct access to 3,3-disubstituted oxindoles through C(sp^3)–C(sp^2) bond formation under mild, metal-free and base-free conditions. The reaction displays broad substrate tolerance and proceeds efficiently in an aqueous MeCN medium, with successful gram-scale synthesis. Mechanistic studies support an ionic pathway involving C3 α-iodination. This work establishes a previously unexplored electrophilic reactivity mode of 3-pyrrol-1-yloxindoles, expanding their synthetic utility beyond their established nucleophilic/Michael-donor behavior.



Keywords: 3-Pyrrol-1-yloxindoles, Cross Dehydrogenative coupling, Umpolung , N, N'-dialkylanilines

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From Bench To Bedside: Formulation, Optimization, And In Vitro Validation Of Novel Thermosensitive Spray Hydrogel For Sports Injuries

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Abstract

The management of sports-related soft tissue injuries necessitates advanced therapeutic platforms that ensure minimally invasive application, conformability to irregular wound sites, and active participation in tissue repair. Conventional hydrogels often face a critical trilemma: balancing optimal deployability (sprayability), rapid in-situ gelation, and post-application mechanical integrity.

Objective: This research aimed to formulate and systematically optimize a thermoresponsive, sprayable hydrogel for sports injuries by addressing the deployability-gelation-mechanics complexity.

Methods: A tri- polymeric system comprising Pluronic F-127 (thermosensitive), Polyvinyl Alcohol (PVA), and Gelatin was developed. A Box-Behnken experimental design was employed to optimize the concentrations of the three polymers, with viscosity (at low shear, for sprayability) and gelling time (at 37°C, for in-situ formation) as the critical response variables. The optimized formulation was characterized for its physicochemical properties, including pH, gelling temperature, and cytotoxicity (HaCaT/L929 cells).

Results: Statistical analysis revealed that Pluronic F-127 concentration was the most dominant factor governing both viscosity ($p < 0.0001$) and gelling time ($p < 0.0001$). The design space navigation successfully decoupled the deployability and gelation requirements. The optimized formulation (Pluronic F-127: 18.5%, PVA: 3.5%, Gelatin: 2.0%) exhibited excellent model validity, with a mean viscosity of 4527.13 cP and a rapid gelling time of 45.00 ± 0.13 seconds at physiological temperature. The formulation demonstrated a skin-compatible pH of 4.80 ± 0.01 and confirmed its preliminary safety profile through in-vitro cytotoxicity assays.

Conclusion: The dual-crosslinking strategy, leveraging primary thermosensitive gelation, successfully resolved the formulation trilemma, yielding a sprayable hydrogel with rapid in-situ solidification and robust mechanical character. This platform presents a promising, patient-centric modality for sports injury management.

Keywords: Sprayable Hydrogel; Sports Injuries; Thermosensitive; Box-Behnken Design; In-situ Gelation; Soft Tissue Repair

Interfacial Physicochemical Interactions Between PVC Microplastics And Acephate Modulate Developmental Biotoxicity in Embryonic Zebrafish (Danio Rerio)

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Abstract

The pervasive use of plastic-based agricultural infrastructure alongside intensive pesticide application has introduced increasingly complex contaminant mixtures into agroecosystems. Progressive weathering and mechanical abrasion of poly (vinyl chloride) (PVC) irrigation materials can generate microplastic (MP) particulates capable of entering adjacent terrestrial and aquatic compartments. Beyond their physical persistence, these particles provide reactive interfaces for the association of co-occurring agrochemicals, potentially altering contaminant bioavailability and biological reactivity. Despite growing recognition of MP-mediated chemical interactions, the developmental and cellular consequences of pesticide-associated agricultural MPs remain insufficiently resolved. Acephate (ACP), a widely applied organophosphate insecticide, was therefore investigated in association with PVC-derived MPs to delineate the comparative in vivo biotoxicity of the individual and combined exposure systems. PVC-derived MPs recovered from agricultural irrigation material were associated with ACP to generate an MP@ACP hybrid, followed by physicochemical characterization. The comparative in vivo biotoxicity of MP, ACP, and MP@ACP was evaluated in embryonic zebrafish (Danio rerio), a sensitive vertebrate model of developmental toxicology. Embryos were exposed to 10-250 µg/mL from 24 hpf to 72 hpf, and developmental and physiological perturbations were assessed through mortality, hatching, spontaneous movement, heart rate, and morphological endpoints. At the cellular level, reactive oxygen species (ROS) generation was quantified by fluorescence-based flow cytometry (FACS), while acridine orange staining was employed to assess apoptotic responses. Comparative evaluation revealed that MP@ACP elicited more pronounced developmental toxicity than the corresponding individual exposures under the tested conditions. The hybrid produced marked morphological perturbations, including yolk sac enlargement and pericardial edema, particularly at higher concentrations. At 72 hpf, FACS analysis demonstrated elevated ROS-associated fluorescence following MP@ACP exposure, accompanied by enhanced acridine orange fluorescence indicative of increased apoptotic responses. The concurrence of developmental abnormalities with oxidative and apoptotic signatures suggests that MP-associated ACP exposure can intensify cellular stress and consequently amplify adverse developmental outcomes. The findings establish a mechanistic continuum linking PVC-derived MP-ACP association with developmental biotoxicity, from altered physiological phenotypes to ROS-associated oxidative stress and apoptotic responses. The enhanced biological reactivity of the MP@ACP system underscores the importance of considering plastic-associated agrochemicals as composite environmental stressors rather than isolated contaminants. These findings provide mechanistic evidence for incorporating MP-pesticide interactions into environmentally relevant frameworks for aquatic toxicological risk assessment.

Keywords - Microplastics, Acephate, PVC, Zebrafish embryos, Developmental toxicity, Oxidative stress, Apoptosis

Development and In Vitro Evaluation of Plga Nanoparticles Encapsulating YM155 And Temozolomide for Glioblastoma Therapy

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Abstract

Glioblastoma (GBM), the most invasive type of brain tumor, is usually treated with temozolomide (TMZ). Unfortunately, the use of TMZ treatment is hampered by inherent and acquired resistance of the tumor. Survivin, the apoptosis inhibitor protein, is highly overexpressed in GBM tumors and linked to a poor prognosis, resistance to treatment, and increased tumor cell survival. As an innovative strategy targeting survivin and bypassing the use of chemotherapy, the small-molecule inhibitor of survivin, YM155, has been identified. This study sought to prove the increased survivin levels in the samples of GBM patients by RT-PCR, thus proving survivin as a target for GBM treatment. On this basis poly(lactic-co-glycolic acid) (PLGA) nanoparticles (NP) have been synthesized encapsulating YM155 and TMZ using the double emulsification (w/o/w) solvent evaporation technique.

Two formulations were characterized separately in terms of their particle size, polydispersity index, zeta potential, drug encapsulation efficiency, and drug in vitro release profile. They were individually tested for their therapeutic potential against the U87-MG human GBM cell line, with the use of HEK-293 cells as the non-tumoral cell line. The viability of the GBM cells analyzed using MTT test indicated that both YM155-NPs and TMZ-NPs decreased significantly GBM cell viability relative to control conditions involving free drugs, sparing HEK-293 cells; hence, tumor selectivity was shown for both preparations. Scratch (or wound-healing) tests showed that both nanoparticles prevented GBM cell migration, but there were differences in the effectiveness between survivin-based nanoparticles and alkylating nanoparticles. Live/Dead test showed enhanced tumor-selectivity of cytotoxicity for both nanoparticles; furthermore, ROS analysis showed increased generation of reactive oxygen species in U87-MG cells treated with both nanoparticles. Overall, the results presented here prove the suitability of survivin as a target for therapy and the feasibility of use of PLGA-based delivery of YM155 and TMZ as independent therapeutic options in the treatment of GBM.

Keywords: Glioblastoma, Survivin, temozolomide, Nanoparticle, Brain delivery, In vitro.

Alkaloid-induced Phase Change And Stabilization Of Copper Imidazole Coordination Polymer

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Abstract

Copper Imidazole frameworks offer pH-responsive release, which makes them advantageous for cancer therapies, as they can degrade in the acidic Tumor Microenvironment (TME). With degradation, the adsorbed drug is released along with Cu2+ ions, which oxidize glutathione (GSH) to GSSG, thereby reducing antioxidant concentrations. Moreover, the reduced Cu+ can catalyze Fenton-like reactions, producing reactive oxygen species. The application of polydopamine (PDA) coating can further enhance the therapeutic effect via photothermal therapy. While the researchers have coated PDA onto carboxylate-based MOFs like Cu-BTC, this lacks the necessary pH-responsive release. To the best of our knowledge, PDA coating on highly pH-responsive copper imidazole frameworks has not been reported, possibly due to the strong interaction between PDA and Cu2+.

Herein, we report a novel Copper-2-Methylimidazole Coordination polymer (Cu-2MIM CP) to overcome this challenge. The addition of a natural alkaloid during the synthesis of the already reported green-colored Cu-2MIM induced a concentration-dependent phase change, with a distinct shift in color from green to brown. Powder X-ray diffraction confirmed the complete phase transformation after 5mg of alkaloid. Interestingly, this new phase could also be obtained without this alkaloid, suggesting that the alkaloid is not required for its formation.

During post-synthetic PDA functionalization, a reported green Cu-2MIM MOF was completely disintegrated. Furthermore, the two identical brown phases, with and without alkaloid, behaved differently. The brown Cu-2MIM CP synthesized in the presence of alkaloid survived, whereas the identical phase synthesized without it underwent disintegration. UV- analysis of post-centrifugation supernatant showed a 2-fold decrease in the absorbance for alkaloid-stabilized CP, compared to that without. The stability of this was further confirmed with PXRD. The peak intensities were simply reduced, suggesting that the structure remained intact post-PDA functionalization.

This alkaloid-mediated stabilization provides a very simple yet robust route for synthesizing a PDA-functionalized copper imidazole framework, which is expected to exhibit pH-responsive release and multifunctional therapeutic effects via the alkaloid and copper ions, as well as photothermal effects via the PDA.

Keywords: Metal Organic Frameworks, Coordination Polymers, Drug Delivery, Chemo dynamic therapy, Photothermal therapy

Ascorbic-Acid-Mediated Reduction of Methylene Blue: UV–Visible Spectroscopy, Kinetics and Implications for Nanomedicine

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Abstract

Methylene blue (MB), a prototypical phenothiazine chromophore with well-defined optical and redox properties, provides a useful molecular platform for investigating reductive dye transformation and reaction kinetics. In the present study, the interaction of MB with L-ascorbic acid (AA), a biologically relevant reducing agent and antioxidant, is systematically investigated using UV–visible spectroscopy. The temporal evolution of the characteristic MB absorption band is monitored following addition of AA, and the spectral changes are correlated with the extent of decolourisation and the underlying redox transformation. Kinetic analysis is performed by following the concentration-dependent decrease in MB absorbance with time, with appropriate pseudo-order/second-order models used to evaluate the rate behaviour and derive the corresponding kinetic parameters. The influence of experimental variables such as reactant concentration and reaction conditions is considered to establish their role in controlling the reduction rate. Particular attention is given to distinguishing spectral bleaching from simple dilution or aggregation effects, thereby providing a chemically meaningful interpretation of the observed UV–visible response.

Beyond its relevance to sustainable chemical treatment of dye-containing systems, the study has significance for nanomedicine because MB is an established photosensitizing scaffold investigated in photodynamic therapy, while MB-loaded nano- and microparticle platforms have been explored for localized therapeutic delivery and light-induced generation of reactive oxygen species. The present work therefore offers a complementary redox perspective on the molecular switching of an optically active therapeutic chromophore. Understanding how a mild biological reductant such as ascorbic acid modulates MB speciation, optical signatures and kinetics can inform the rational design of redox-responsive nanocarriers, activatable photosensitizers and theranostic platforms in which optical state and biological microenvironment are coupled. The study establishes a simple, spectroscopically traceable model system for connecting fundamental redox kinetics with the broader molecular design principles of precision nanomedicine.

Keywords: Methylene blue; L-ascorbic acid; UV–visible spectroscopy; reaction kinetics; redox chemistry; photosensitizer; nanomedicine; theranostics; photodynamic therapy.

Selective Detection Of C-reactive Protein For Neonatal Sepsis With A Molecularly Imprinted Polymer Incorporated Nickel-doped Cobalt Ferrite Nanoparticle

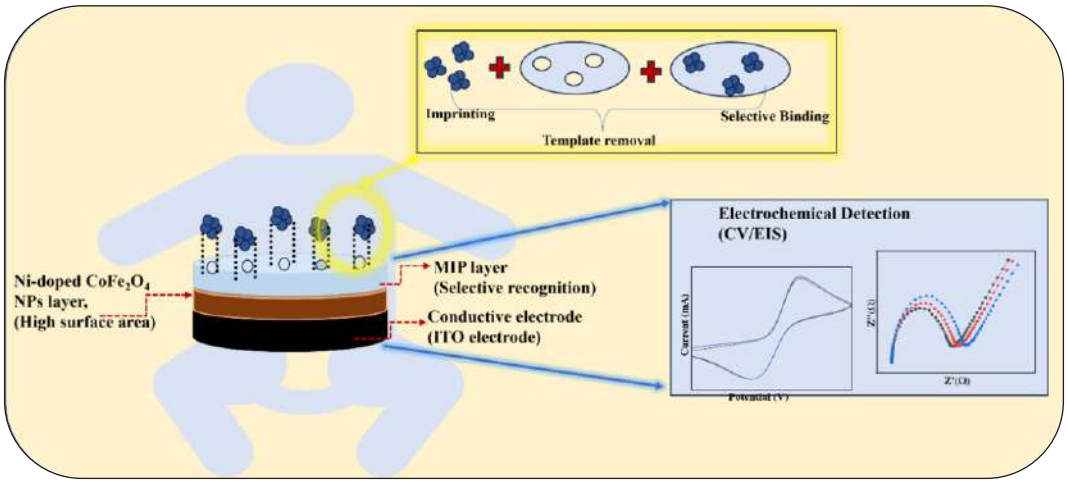
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Abstract

Neonatal sepsis is associated with exceptionally high mortality and morbidity rates, making it a potentially fatal condition. Sepsis remains difficult to diagnose because of its non-specific clinical presentation. Blood culture can be used to diagnose it, but it is time-consuming. Therefore, to diagnose newborn sepsis and start therapy as soon as possible, a reliable marker is required. Thus, C-reactive protein is used for detection as an important marker associated with sepsis. In this work, an electrochemical sensor based on a NixCoFe2O4/MIP/ITO electrode was modified for highly selective and sensitive detection of C-reactive protein, which could potentially be utilised for the diagnostic procedure for newborn sepsis. Incorporation of MIP in doped NPs enhances the conductivity of the electrode and provides a large surface area, which improves the electron transfer. Electrochemical analysis was carried out using CV and EIS techniques, with an LOD of 0.12 ng/mL and a response time of 15 min. This electrochemical sensor is suitable for quick CRP detection for sepsis and could be used for point-of-care neonatal sepsis diagnosis. Furthermore, the NixCoFe2O4/MIP/ITO electrode provides a reliable and affordable method for biomarker detection. Identification, with the MIP layer being essential to obtaining accurate and selective recognition.

Keywords: Early-onset sepsis, Infectious diseases, C-reactive protein, Electrochemical impedance spectroscopy, cyclic voltammetry, Hydrothermal method, Molecularly imprinted polymer.



Beyond Antibiotics: Latarcins, A Family Of Spider Venom Derived Antimicrobial Peptides As Nanobiotics

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Abstract

Membrane Active Peptides (MAPs) are therapeutically significant molecules; they are evolutionarily a part of defence mechanism and innate immune response for various species. By targeting the cell membrane, Antimicrobial Peptides (AMPs), a class of MAPs shut the critical biological processes required for bacterial survival such as membrane potential, ionic balance, proton motive force which are directly associated with the synthesis of Adenosine Triphosphate (ATP) thus disrupting the cellular homeostasis eventually leading to cell death. Despite their potential, the precise mechanisms of MAPs at the cellular and molecular level remains intriguing. Our current research investigates the characteristics as well as the therapeutic potential of a class of spider venom-derived MAPs called Latarcins. Latarcins is a 7-member AMP family which exhibits broad-spectrum antimicrobial properties, causing membrane damage mediated microbial killing. Secondary structure analysis of Latarcins revealed that all 7 peptides are random coil in aqueous conditions and transition into alpha-helical conformation during their membrane interaction. Interestingly, our in vitro functional assays confirmed that these MAPs exhibit different degree of antimicrobial activity despite they share similar amino acid composition. Hence, in this work we attempted to determine the critical factors that fine-tunes the variations in the antimicrobial activity of Latarcin family peptides. Our all-atom simulations revealed the role of physico-chemical properties and the arrangement amino acids in the peptide sequence in determining the extent of membrane interaction strength of Latarcins and thus influencing their antimicrobial properties. Particularly, the distribution of charged and hydrophobic residues in the three-dimensional structure of the peptide and their dynamics during membrane interaction determine their membrane binding strength. Mechanistically, the initial electrostatic interaction between cationic residues and anionic phospholipid head groups drives the initial attachment of peptides on the membrane surface, where further hydrophobic partitioning triggers localized membrane destabilization, pore formation, or transient disruption. The insights gained from our integrated in silico and in vitro analysis provide a useful framework for designing novel nanobiotics with optimized therapeutic profiles, including high efficacy, membrane selectivity, and strain-specific activity.

Keywords: Antimicrobial resistance, Antimicrobial Peptides, Infectious diseases, Drug discovery and development

Engineered Biomaterial-phage Cocktail Conjugate For Eradication Of Mature Polymicrobial Biofilms Caused By Multidrug-resistant Uropathogens

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Abstract

The ability of multidrug-resistant (MDR) uropathogens to form polymicrobial biofilms, which promotes the antibiotic resistance and makes treating urinary tract infections (UTIs) more challenging, is a major clinical problem. Bacteriophage therapy is now being used as an effective alternative to combat these pathogens. However, efficient phage delivery and sustained activity at the infection site remain key challenges. In this study, engineered phage cocktail-loaded biomaterial developed to treat mature polymicrobial biofilms produced by MDR uropathogens. Conventional methods were used to isolate phages from sewage and wastewater samples, which were then purified by plaque assay. A phage cocktail was developed utilizing a combination of phages based on their host range and lytic efficiency. The designed phage cocktail's therapeutic potential was then assessed against polymicrobial biofilms, which are produced by MDR uropathogens by in-vitro biofilm assays. In comparison to individual phage treatments and untreated controls, the phage cocktail exhibited a significant reduction in viable bacterial biomass and a substantial disruption of biofilm architecture, demonstrating a synergistic antibiofilm action. The obtained results demonstrate the possibility of a stability-optimized multi-phage cocktail as a successful treatment strategy against MDR uropathogens that cause polymicrobial biofilm-associated with UTIs. Future work aims to encapsulate a biodegradable elastomeric biomaterial with phage and to characterize the integrated platform to enhance the overall effectiveness against established polymicrobial biofilms.

Keywords: MDR uropathogens, Urinary tract infection, Bacteriophage therapy, Polymicrobial biofilm, Phage cocktail, Biomaterial.

Biological Assessment Of Green-synthesized Ag@zno Nanocomposites: ExploringMolecular Interactions Associated With Cellular Oxidative Stress And Apoptotic Response In Zebra Fish (danio Rerio)

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Abstract

The rapid expansion of multifunctional nanomaterials has increased their potential environmental dissemination, raising important concerns regarding their biological effects and safety. In this study, a silver-zinc oxide (Ag@ZnO) nanoconjugate was developed using a green synthesis approach mediated by Trachyspermum ammi leaf extract and its developmental and cellular effects were investigated in zebrafish (Danio rerio) embryos. Comprehensive physicochemical characterization by ultraviolet-visible spectroscopy (UV), Fourier transform infrared spectroscopy (FTIR), scanning electron microscopy (SEM) coupled with energy dispersive X-ray spectroscopy (EDX) and zeta potential analyzers to elucidate the successful formation of the nanoconjugate, along with homogeneous elemental distribution and enhanced surface characteristics. Comparative toxicity evaluation revealed that Ag@ZnO exerted more pronounced developmental effects than the corresponding individual Ag and ZnO nanoparticles. Increasing exposure to Ag@ZnO resulted in reduced embryo viability, delayed hatching, alterations in cardiac activity, and distinct morphological abnormalities, including pericardial edema, yolk sac enlargement, axial deformities, and delayed development. Flow cytometric assessment demonstrated enhanced accumulation of the nanoconjugate within embryonic tissues, which was associated with increased reactive oxygen species (ROS) generation and elevated apoptotic activity.

To further explore the molecular basis of these effects, in silico interaction studies were conducted against proteins involved in zebrafish development and antioxidant defense, including Zhe1 and Sod1. The stronger predicted interactions observed for Ag@ZnO suggest a possible influence on developmental regulation and antioxidant defense mechanisms. Overall, the findings indicate that the integration of Ag and ZnO into a single nanoconjugate can markedly modify their biological activity and produce greater toxicity than that observed for the individual nanoparticles. The study further highlights a potential mechanistic sequence linking nanoconjugate accumulation with oxidative stress, apoptosis, and impaired embryonic development. These findings contribute to a better understanding of the biological behavior of green-synthesized metal/metal oxide nanoconjugates and reinforce the importance of comprehensive mechanistic safety evaluation prior to their expanded environmental and biomedical applications.

Keywords: Nanoconjugate, Green synthesis, Oxidative stress, Apoptosis, Environmental risk assessment, Zebrafish embryo

Identification And Translational Development Of Natural Bioactive Compounds Targeting The Sclerostin–lrp5/6 Axis For Osteoanabolic Therapy

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Abstract

Sclerostin-mediated inhibition of Wnt signaling is a major negative regulatory mechanism of bone formation and represents an established therapeutic target in osteoporosis. The development of orally active small molecules targeting this axis may provide an alternative to antibody-based sclerostin inhibition. We therefore adopted an integrated computational, biological and pharmaceutical approach to identify and advance natural bioactive compounds targeting the sclerostin–LRP 5/6 axis.

Methods: A natural-product-based computational screening strategy incorporating molecular docking, pharmacophore modelling, clustering and structure–activity analysis was used to prioritize candidate sclerostin–LRP interface inhibitors. Sixteen selected compounds were subsequently screened for osteogenic activity in primary mouse osteoblasts using alkaline phosphatase (ALP) activity. Lead candidates were further evaluated using the LEADING LIGHT® sclerostin–LRP interaction assay, and diosmetin and fisetin were selected for further study based on their inhibitory potency. Osteogenic activity was subsequently assessed in differentiated IDG-SW3 osteocyte cells using ALP staining. To address formulation challenges associated with oral delivery, HPβCD-based formulations were developed and evaluated for physicochemical characteristics. The formulations were subsequently assessed in an ovariectomized rat model of postmenopausal osteoporosis at an oral dose of 25 mg/kg. Based on the comparative in-vivo outcome, an emulsion-based formulation strategy was subsequently developed using Capryol 90, Kolliphor RH 40 and Transcutol HP.

Conclusion: The integrated screening strategy identified diosmetin and fisetin as natural compounds with osteogenic activity and inhibition of the sclerostin–LRP5/6 interaction. Although HPβCD-based solubilisation produced physically stable oral formulations, the absence of a significant efficacy advantage over API in the OVX model highlighted a formulation-to-efficacy gap. Reformulation using an emulsion-based delivery strategy represents the next step toward improving oral delivery, with subsequent pharmacokinetic and in-vivo efficacy studies planned to determine whether the revised formulation provides improved therapeutic translation.

Keywords: Osteoporosis | Sclerostin–LRP5/6 | Drug Delivery | Diosmetin | Fisetin

Nanoparticle-mediated Targeted Delivery Of Drug Suppresses Breast Tumour Growth

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Abstract

Triple-negative breast cancer (TNBC), is represented by the absence of estrogen, progesterone, and HER2 receptor expression. It accounts for approximately 15–20% of all breast cancer diagnoses worldwide. TNBC remains one of the most aggressive and therapeutically challenging subtypes, which is marked by high metastatic potential and poor survival rate. Cytotoxic chemotherapy remains one of the most widely used treatment options in the absence of targeted receptor-based therapies. However, its clinical efficacy is confined by poor aqueous solubility, non-specific bio-distribution, rapid first-pass metabolism, resulting in systemic toxicity. These limitations highlights the necessity for delivery systems that improve tumor selectivity while maintaining safety. Nanoparticle-based drug delivery systems have emerged as a promising strategy to overcome these limitations by improving drug pharmacokinetics, enabling tumor-selective accumulation, and attenuating off-target effects. A wide range of nanocarriers, including liposomes, solid lipid nanoparticles, polymeric nanoparticles, nanoemulsions, extracellular vesicles, and chitosan-based systems, are now being used for TNBC therapy, several of which have progressed to clinical or advanced pre-clinical evaluation. Chitosan nanoparticles (CHNPs) have emerged as prominent nanoparticles owing to their inherent biocompatibility, biodegradability, mucoadhesive properties, and pH-responsive behavior. These characteristics can facilitate enhanced drug delivery and cellular uptake within the acidic tumor microenvironment. Surface functionalization of CHNPs with the cyclic RGD peptide further enables active, receptor-mediated targeting of αvβ3 integrin, an adhesion receptor over-expressed on TNBC cells and tumor-associated endothelium but largely absent from normal tissue. In a representative pre-clinical study, RGD-conjugated CHNPs loaded with the selective estrogen receptor modulator raloxifene showed remarkable greater colloidal stability, cellular internalization, and cytotoxicity at acidic pH, with RGD conjugation providing an additional, integrin-dependent boost in uptake and apoptosis that was reversed by receptor blockade. Mechanistically, the RGD-targeted, pH-responsive formulation (CHNP-RGD-Raloxifene) suppressed Akt/ERK signalling and translates into reduced migration and invasion in vitro. This formulation achieved better tumor localization and greater inhibition of tumor growth than the non-targeted nanoparticle and free drug in orthotopic tumor models. Haematological, biochemical, and histopathological analysis revealed an excellent biocompatibility and negligible toxicity to normal tissues. Taken together, these results suggested that ligand-based (RGD-conjugated CHNPs) targeting can significantly improve the therapeutic index of poorly bioavailable anticancer agent (Raloxifene) in TNBC by concentrating drug release and cellular uptake preferably within the tumor microenvironment.

Keywords: Triple-negative breast cancer, nanoparticles, chitosan, RGD peptide, Raloxifene

Therapeutic Potential of Biofabricated Metal Nanoparticles Against Ovarian Cancer

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Abstract

Ovarian cancer represents a major therapeutic challenge owing to its heterogeneous biology, frequent late-stage diagnosis, recurrence, metastatic dissemination, and the development of resistance to established treatment modalities. Although advances in surgery, chemotherapy, targeted therapy, and maintenance strategies have improved clinical management, persistent therapeutic limitations underscore the need for complementary approaches capable of addressing multiple determinants of tumour progression. Nanomedicine provides an attractive framework in this context because nanoparticles can integrate physicochemical functionality, biological activity, surface-mediated interactions, and multimodal therapeutic effects within a single platform. The present study explored the therapeutic potential of selenium and silver nanoparticles biofabricated using Sinapis nigra seed extract (MS-SeNPs and MS-AgNPs) as multifunctional nanotherapeutic candidates against ovarian cancer. The nanoparticles were generated through a green biofabrication strategy in which S. nigra phytoconstituents served as natural reducing, capping, and stabilizing agents, producing phytochemical-functionalized nanomaterials with distinct physicochemical characteristics. Comprehensive characterization confirmed successful nanoparticle formation, nanoscale architecture, crystallinity, surface functionalization, and colloidal stability. The biological evaluation demonstrated a broad spectrum of activity rather than a single therapeutic effect. Both nanoparticle systems exhibited concentration-dependent antioxidant activity against DPPH, hydrogen peroxide, and nitric oxide, while MS-SeNPs demonstrated broad-spectrum antibacterial activity against representative Gram-positive and Gram-negative bacterial pathogens. Combination of MS-SeNPs with amoxicillin further enhanced antibacterial efficacy, highlighting their potential as complementary antimicrobial nanoplatforms. Against TOV112D ovarian cancer cells, both nanoparticles produced concentration-dependent cytotoxicity, with MS-SeNPs demonstrating comparatively greater anticancer potency than MS-AgNPs. The nanoparticles also markedly suppressed cancer-cell migration in the scratch assay, with MS-SeNPs exhibiting the stronger anti-migratory response. Intracellular ROS analysis using DCFH-DA demonstrated progressive increases in ROS-associated fluorescence following nanoparticle exposure, suggesting perturbation of cellular redox homeostasis as one potential contributor to their anticancer activity. Collectively, the results establish a coherent multifunctional biological profile involving antioxidant activity, antimicrobial action, cytotoxicity, inhibition of cancer-cell migration, and modulation of intracellular oxidative status. The convergence of these activities is particularly relevant to ovarian cancer, where therapeutic resistance, tumour heterogeneity, recurrence and metastatic progression remain significant challenges. The therapeutic promise of these materials therefore lies not simply in their ability to kill cancer cells, but in their potential to influence several interconnected biological processes through a single nanoscale platform. Their phytochemical-functionalized surfaces may additionally contribute to nanoparticle stability and biological interactions, while green biofabrication offers a comparatively sustainable route for generating biologically active nanomaterials. Among the two systems, the overall biological profile positions MS-SeNPs as the more promising candidate for further ovarian cancer nanomedicine research, while MS-AgNPs provide an important comparative metal-nanoparticle platform.

Hybrid Quantum–Classical Machine Learning Framework for Computational Drug Screening Using VQE, GNNs, and QAOA

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Abstract

Drug discovery with computational approaches requires high accuracy of molecular property prediction, safety profiling, and optimization of multi-drug regimens – problems that separately challenge classical approaches and do not have a unified solution. In this work, we propose a hybrid quantum-classical approach that connects four modules for comprehensive evaluation of pharmaceutical compounds. First, an ensemble learning machine layer is proposed where an ensemble of two models: Graph Attention Network (GATv2) applied to molecular graphs and Transformer encoder working with SMILES representation with uncertainty estimation and RDKit descriptor-based Random Forest baseline is considered as Fig.1. The ensemble provides consistently improved RMSE for ten pharmacological targets related to toxicity, bioavailability, solubility, and binding affinity. Second, a Variational Quantum Eigensolver (VQE) module computes molecular electronic structure Hamiltonians from PySCF Hartree–Fock calculations mapped to qubits with Jordan–Wigner mapping implemented in Qiskit Nature. Active space dimensionality reduction to 2–12 qubits allow for computing ground state energy and validating it with classical Hartree–Fock calculations in order to estimate recovered correlation energy. Third, ADMET profiling is performed using a trainable graph neural network model for 29 endpoints with calibrated Lipinski/Veber rules as a fall-back mechanism. Fourth, multi-drug regimen design is formulated as a Quadratic Unconstrained Binary Optimization (QUBO) problem where synergies are treated as a reward and antagonism as penalty and then solved using Quantum Approximate Optimization Algorithm (QAOA) compared to exact and greedy solutions. Ablation studies demonstrate that quantum descriptors, learned molecular embeddings and ML-based ADMET provide independent improvements in overall drug-likeness with the combination being most informative. The open-source platform combines a FastAPI backend and Next.js frontend allowing interactive single and multi-drug analysis.

Keywords: Quantum computing, drug discovery, variational quantum eigensolver, graph neural networks, SMILES transformer, drug–drug interactions

Methodology

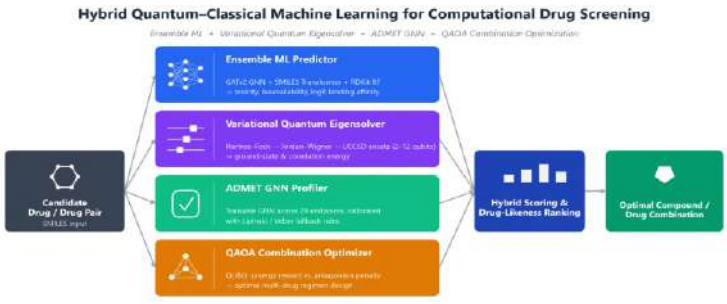


Fig. 1 show the schematic representation of Machine Learning based drug screening system

Iron-Catalyzed Stereoselective Cyclization Of O-tethered Enynes And Ddq-mediated Oxidative Annulation To Dibenzofurans

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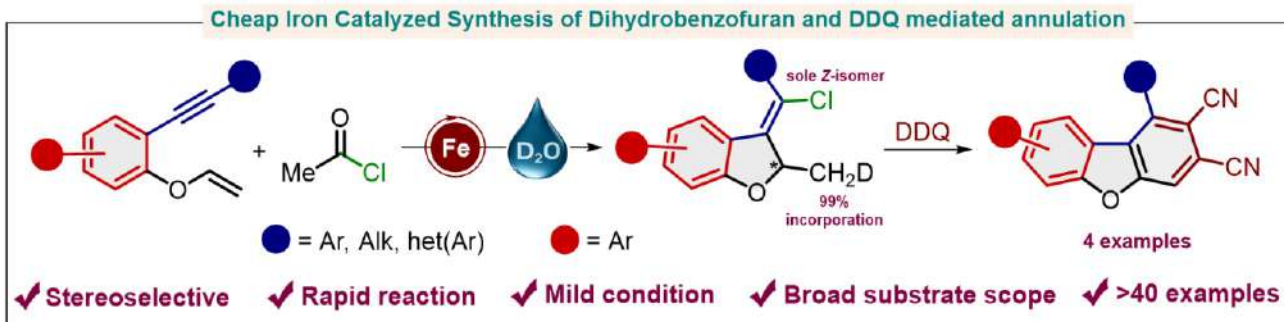
Abstract

Abstract: An iron-catalyzed stereoselective cyclization of O-tethered enynes has been developed, providing facile access to 2-methyl-2,3-dihydrobenzofuran derivatives in good to excellent yields. The transformation proceeds through an acetyl chloride–assisted intramolecular addition under mild conditions, generating alkenyl chloride intermediates with exclusive Z-selectivity. More than 99% deuterium incorporation was obtained when D2O was used instead of H2O. Subsequent DDQ-mediated oxidative aromatization furnishes phenyldibenzofuran-2,3-dicarbonitrile derivatives in excellent yields via a dehydrogenative annulation pathway. This operationally simple and ligand-free method offers a cost-effective and stereospecific approach to densely functionalized heteroaromatic frameworks, which can serve as versatile synthetic platforms for further diversification through cross-coupling reactions.

Keywords: Deuteration, Di-Hydrobenzofurans, Oxidation.

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Nanocarrier Reformulation Versus Novel Therapeutic Modality: A Comparative Narrative Review Of Clinical Translation In Therapeutic Nanomedicine

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Abstract

Nanocarrier-based drugs fall into two distinct categories. More commonly, an existing drug is repackaged in a nanocarrier – the active ingredient stays the same, but its release and pharmacokinetic behaviour is improved. The other category is where the therapeutics is driven by the nanocarrier itself. Without it, the therapy would not exist in a deliverable form at all. Most reviews of nanomedicine are organised around disease area rather than around this reformulation-versus-novel-modality distinction, which makes it difficult to discern which approach is more likely to yield a therapy that gains quick and reliable regulatory acceptance.

Objective: This review tries to identify which of the two approaches to nanomedicine development, repackaging-based reformulation of an existing drug or a genuinely novel nanoparticle-based therapeutic modality, is more likely to succeed in reaching approved clinical use, based on published literature.

Methods: Peer-reviewed clinical trials, meta-analyses, and landscape reviews were identified through PubMed/PMC, limited to open-access, indexed sources. Each nanomedicine was sorted into one of two groups – reformulation of an existing drug, or a genuinely new modality – and compared descriptively by approval status and depth of clinical evidence.

Results: Based on the analysis of literature, it appears that the repackaging based approach succeeded faster and more consistently. Liposomal doxorubicin reduced cardiotoxicity compared with conventional doxorubicin (4.7% vs. 19.6%, P<0.001), a finding backed by a meta-analysis of nine trials (OR 0.34, 95% CI 0.24–0.47 for heart failure). In visceral leishmaniasis, a single dose of liposomal amphotericin B worked as well as fifteen infusions of the conventional drug in a large Indian cohort. A real-world Indian study of 1,800 patients found nanoparticulate iron produced a remarkable haematologic response. Liposomal bupivacaine and iron-oxide MRI contrast agents such as Feraheme are already in routine clinical use. In all the above described examples, the nanocarrier only changes how a known, already-tested drug behaves in the body. It does not introduce a new active principle. The other approach, where the nanoparticle size drug itself is novel, a different picture emerges. Patisiran, approved in 2018, is still one of the few siRNA-lipid nanoparticle drugs in the market, despite RNA interference having been studied for over two decades. mRNA-lipid nanoparticle vaccines beyond COVID-19, are mostly still in clinical trials, with just one further approval so far, for RSV. Nanocarriers designed to cross the blood-brain barrier for Alzheimer's disease, Parkinson's disease, and glioblastoma remain in preclinical evaluation or early-phase clinical trials, even though the blood brain barrier blocks over 98% of small molecules by conventional routes. A great deal of research effort has gone into solving this.

Cell-penetrating Peptides As Dual-function Platforms For Antifungal Nanomedicine And Cns-directed Drug Delivery

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Abstract

Fungal infections of the central nervous system (CNS) represent a major therapeutic challenge, with the pathogen infecting the brain, Cryptococcus neoformans is a leading cause of fatal cryptococcal meningitis, particularly in immunocompromised patients. The treatment of cryptococcosis is further complicated by the small antifungal arsenal, drug-related toxicity, long duration of treatment, emerging resistance, and unique biological features such as polysaccharide capsule and melanin that contribute to virulence and protection from host immune responses. Furthermore, the blood–brain barrier (BBB) presents an additional physiological barrier to the delivery of therapeutics to sites of CNS infection. These barriers point out the need for innovative therapeutic platforms that can combine both antifungal activity with efficient delivery across biological barriers. Cell-penetrating peptides (CPPs) have emerged as promising prospects because their cationic and amphipathic nature allows them to interact with negatively charged biological membranes and can promote cellular translocation of peptide or molecular cargo across the membrane. CPPs can serve not only as potent nanocarriers but may also possess intrinsic antimicrobial activity, finding use in nanotheragnostics. The antifungal potential of CPPs was assessed against C. neoformans, with selected arginine-rich peptides from our inventory investigated for their therapeutic potential. The findings demonstrated promising antifungal activity, with one candidate exhibiting particularly potent activity against C. neoformans. Building on the preliminary findings, ongoing studies are focused on elucidating the mechanism of action of the selected peptides and exploring their potential for CNS-directed delivery across the BBB. The observed antifungal activity, together with the established potential of CPPs as drug delivery systems, provides a rationale for developing a CPP-based dual-function platform that combines intrinsic therapeutic action with targeted delivery across biological barriers.

Keywords: Cell-penetrating peptides, Cryptococcus neoformans, Tat-derived peptides, Nanomedicine, Blood–brain barrier.

Dynamic Microparticles For The Eradication Of Uric Acid Deposits In Inflamed Articular Microenvironments

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Abstract

Gout is a metabolic disorder characterized by the accumulation of monosodium urate crystals (MSU) in the joints. The study aims to prepare Uricase functionalized PLGA-loaded colchicine dynamic microparticles (Col-PM@Ur) that can move in the viscous fluid barrier in the synovial cavity. We have fabricated biohybrid micro-motors that generate efficient propulsion by harnessing biocatalytic reactions with endogenous biofuels available in the diseased microenvironment, in this case, uric acid. This synergistic strategy simultaneously reduces the MSU crystal burden and mitigates the associated inflammatory response. Col-PM@Ur was fabricated via double emulsion solvent evaporation, and characterized by FESEM, DSC, FTIR, and PXRD. Uricase was surface-immobilized, and its activity was validated by uric acid degradation by UV-Vis and peroxidase-coupled colorimetric assay. Stability was evaluated under varying pH, temperature, and protease conditions. Particle mobility was assessed using MSD and the diffusion coefficient (Dt). Cytocompatibility was assessed in HIG-82 synoviocytes, followed by in vivo therapeutic evaluation in the MSU-induced gout model in Sprague-Dawley rats. The formulation retained >70% catalytic activity under varying pH, temperature, and protease conditions. Single particle tracking analysis demonstrated enhanced mobility with MSD increasing from 9.57 μm2 to 83.16 μm² μm2 over 20 seconds. Diffusion coefficient Dt also increased from 0.11±0.035 μm2/s to 0.86±0.24 μm2/s. The formulation exhibits >92% cell viability in HIG-82 synoviocytes up to 200μg/mL. In the MSU-induced gout model, intra-articular Col-PM@Ur reduced knee edema by 72% significantly and suppressed IL-1β, TNF-α, and IL-8, restored synovial and cartilage architecture, showed no organ toxicity, and demonstrated prolonged intra-articular retention through ICG imaging. Current drug delivery platforms struggle to navigate the gout's complex microenvironment. This approach demonstrates that the particle design can overcome biological barriers and deliver the drug effectively into the deeper joint tissues. This work is the basis of the next generation polymer-drug/enzyme systems requiring fewer administrations and minimizing the patient burden.

Keywords: Micromotors, Gouty arthritis, Intra-articular delivery, Uricase

Size- And Architecture-dependent Transport Of Dna Nanocages In Multicancer Three-dimensional Tumour Spheroids

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Abstract

The effectiveness of nanoparticle-based drug delivery depends on both nanocarrier properties and the characteristics of the tumour microenvironment. Although DNA nanocages offer programmable control over nanoscale architecture, how their size and geometry influence transport across different tumour types remains poorly understood. This study investigates the influence of DNA nanocage architecture on cellular uptake, penetration and retention in three-dimensional tumour spheroid models.

DNA tetrahedra of three sizes (small, medium and large) and DNA buckyballs will be evaluated in spheroids derived from breast, cervical, lung and oral cancer cell lines. These multicellular models provide a physiologically relevant system that better represents tumour architecture, cell-cell interactions and diffusion barriers than conventional two-dimensional cultures. Time-dependent confocal imaging and quantitative image analysis will be used to compare the transport profiles of different DNA nanocage architectures across tumour models.

We hypothesise that differences in tumour architecture and spheroid compactness will influence nanoparticle transport, resulting in tumour-specific structure-function relationships. By determining how nanocage architecture interacts with tumour characteristics, this study aims to identify design principles for selecting nanocarriers according to tumour-specific delivery requirements. Future studies will extend these findings to heterotypic tumour spheroids and zebrafish models, providing a stepwise approach toward evaluating DNA nanocages in increasingly complex biological systems and their potential application in precision drug delivery.

Keywords: DNA nanocages; Precision nanomedicine; Drug delivery; Tumour spheroids; Tumour microenvironment; Nanoparticle transport; Cancer heterogeneity

Development of Liquid Nanocrystal Structural System for Improved Chemotherapeutic Efficacy

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Abstract

Breast cancer remains a major therapeutic challenge, underscoring the need for targeted nanotherapeutic strategies capable of enhancing drug delivery and overcoming therapeutic limitations. In the present study, we developed a dual-drug-loaded nano-liquid crystal (NLC) system incorporating Celastrol and Tamoxifen for enhanced anticancer efficacy against breast cancer. An analytical HPLC method was established for the simultaneous characterization and quantification of both therapeutic agents. The developed NLCs exhibited a mean hydrodynamic diameter of approximately 217 nm with a surface charge of −16.8 mV. Their physicochemical and morphological characteristics were further elucidated using dynamic light scattering (DLS), scanning electron microscopy (SEM), transmission electron microscopy (TEM).

The biological performance of the dual-drug NLCs was systematically evaluated in MCF-7 and MDA-MB-231 breast cancer cells using flow cytometry and complementary cellular assays. The nanocarrier demonstrated efficient and time-dependent intracellular uptake, with pronounced cellular internalization observed following 1 h and 6 h of treatment. Furthermore, treatment with the dual-drug NLCs induced substantial oxidative stress, as evidenced by enhanced ROS generation using DCFH-DA, accompanied by alterations in mitochondrial membrane potential, induction of apoptosis, and cell-cycle perturbation. Collectively, these findings demonstrate that the Celastrol-Tamoxifen co-loaded NLC platform represents a promising multifunctional nanotherapeutic strategy for enhancing intracellular drug delivery and exerting synergistic anticancer effects against breast cancer.

Keywords: Nanotherapy, Breast Cancer, Nano-liquid crystals

Plant-Mediated Green Synthesis of Copper Oxide Nanoparticles from Neolamarckia cadamba Leaf Extract: Antioxidant and Antibacterial Assessment

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Abstract

Copper oxide nanoparticles (CuO NPs) were synthesized in this study through a green, plant-mediated synthesis using leaf extract of Neolamarckia cadamba, providing a simple, eco-friendly, and cost-effective alternative to conventional nanoparticle synthesis methods. Structural, optical, and morphological characterization of the synthesized CuO NPs was carried out using XRD, UV–Vis spectroscopy, photoluminescence (PLS), SEM, and FTIR. The crystalline nature of the nanoparticles was confirmed through XRD analysis, while UV–Vis spectroscopy exhibited a strong absorption band, from which the band gap energy consistent with nanoscale CuO was calculated. Structural disorder within the nanoparticles was further assessed through evaluation of the Urbach energy. SEM analysis revealed uniformly distributed, well-dispersed nanoparticles, and FTIR confirmed the presence of phytochemical functional groups from the leaf extract responsible for capping and stabilization of the nanoparticles. Antioxidant assays demonstrated notable free radical scavenging activity of the synthesized CuO NPs. Antibacterial evaluation, particularly against Clostridium perfringens, further revealed strong inhibitory effects, highlighting the antimicrobial potential of the nanoparticles. Collectively, these findings indicate that the green-synthesized CuO NPs possess multifunctional properties with promising applications in the environmental and biomedical domains.

Keywords: Copper oxide nanoparticles, Neolamarckia cadamba, Plant-mediated green synthesis, Antibacterial activity, Antioxidant properties

Ferrite-based Magnetic Nanocomposites as Emerging Nanoformulations for Lung Cancer Therapy

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Abstract

Lung cancer is the leading cause of cancer mortality worldwide, with approximately 2.5 million new cases and 1.8 million deaths in 2022 (GLOBOCAN). The use of traditional chemotherapy, with its lower selectivity for tumor cells, systemic toxicity and multidrug resistance (particularly for non-small cell lung cancer), is a major limiting factor. Lung cancer patients are also at higher risk for secondary respiratory infections (such as Pseudomonas aeruginosa and Staphylococcus aureus) that are typically multidrug resistant. This makes it crucial to develop multifunctional nanoplatforms combining anticancer and antibacterial agents in one nanocarrier system. Ferrite-based magnetic nanoparticles represent a promising nanoformulation platform because of the combination of its magnetic, catalytic and biological functions, making the platform highly attractive for targeted drug delivery and biomedical therapeutics. Ferrite-based magnetic nanoparticles (e.g. Fe_3O_4) offer a versatile platform to fabricate versatile multifunctional nanocomposites. In this study, we report on the fabrication of a core–shell Fe3O4@SiO@PDA@Ag nanocomposite and its evaluation for physicochemical and biological activity against lung cancer cells and bacterial cells. This formulation design involved the surface modification of the magnetic Fe_3O_4 nanoparticles with a silica layer which enabled the negatively charged surface, followed by the functionalization of polydopamine to allow for immobilization of silver nanoparticles as the final stage of the nanoformulation. The SEM-EDX, TEM, FTIR, XRD and DLS of the nanocomposite were determined. The biological activity of the nanocomposite was investigated against a H1299 human lung cancer cell line using MTT assay. It showed concentration-dependent cytotoxic activity with an IC50 of 21.52 µg/ml. The antibacterial activity against Pseudomonas aeruginosa and Staphylococcus aureus was evaluated and its minimum inhibitory concentration was determined to be approximately 115 µg/ml. Fe_3O_4@SiO_2@PDA@Ag nanocomposite could be further explored as a multifunctional platform for targeted lung cancer therapy and antibacterial treatment. Its magnetic properties may enable magnetically guided drug delivery and magnetic hyperthermia, while the surface could be modified for loading anticancer drugs or targeting molecules. Future studies should focus on optimizing therapeutic efficiency, biocompatibility, biodistribution and in vivo safety, with the long-term goal of developing a combined anticancer and antimicrobial nanotherapeutic system.

Keywords: Ferrite Nanoparticles, Nanocomposites, core-shells, antibacterial

Enhancing Ciprofloxacin Activity Against Clinical Ciprofloxacin-resistant Escherichia Coli: Antimicrobial Peptides, Fosfomycin, And Efflux Modulation

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Abstract

Escherichia coli (E. coli) is a leading cause of urinary tract infections worldwide, while antimicrobial resistance (AMR) poses a growing public health threat, contributing to over 1.2 million deaths annually in 2019 and projected to cause 10 million deaths per year by 2050. Extensive and often inappropriate use of fluoroquinolones, particularly ciprofloxacin, has accelerated resistance development in E. coli, largely driven by target-site mutations and efflux pump overexpression, thereby severely limiting therapeutic options. Innovative strategies that enhance antibiotic efficacy are therefore urgently required to address this challenge.

In this study, the antibacterial activities of Crotalicidin (Ctn), Latarcin-2a (Ltc-2a), and Tat-2 were evaluated individually and in combination with ciprofloxacin against clinical ciprofloxacin-resistant E. coli isolates. Minimum inhibitory and bactericidal concentrations (MIC/MBCs) were determined by broth microdilution. Drug interactions were assessed using checkerboard assays and fractional inhibitory concentration indices (FICIs), while the contribution of efflux mechanisms to ciprofloxacin resistance was examined using carbonyl cyanide 3-chlorophenylhydrazone (CCCP). Cytotoxicity was evaluated in HeLa cells using the MTT assay.

Ctn and Ltc-2a consistently showed MIC/MBC values of 8/16 µg/mL, whereas Tat-2 showed greater activity against E. coli-01 (MIC/MBC, 2/8 µg/mL). Ciprofloxacin–Ltc-2a combinations produced strain-dependent enhancement of ciprofloxacin activity, with ciprofloxacin MICs decreasing 32-fold in both E. coli 01 and E. coli 02, with FICIs of 0.75 and 0.53125, respectively, indicating additive interactions. Ciprofloxacin–fosfomycin combinations showed synergy against E. coli 01, R329, and R73 (FICI = 0.3125–0.50), while an additive interaction occurred against R38 (FICI = 0.625). In E. coli 01, ciprofloxacin and fosfomycin MICs decreased 16-fold and 4-fold, respectively. Addition of CCCP further reduced the ciprofloxacin MIC to <1 µg/mL (≥64-fold), supporting a contribution of efflux activity to ciprofloxacin resistance and indicating substantial restoration of ciprofloxacin susceptibility following efflux inhibition. Cytotoxicity analysis showed that Ctn exhibited excellent biocompatibility, with ciprofloxacin–Ctn combinations maintaining ≥75% HeLa cell viability.

Overall, these findings demonstrate strain-dependent enhancement of ciprofloxacin activity through antimicrobial peptide combinations and additive or synergistic interactions with fosfomycin. The pronounced reduction in ciprofloxacin MIC following CCCP treatment further supports the contribution of efflux activity to ciprofloxacin resistance and highlights efflux modulation as a complementary approach for restoring ciprofloxacin susceptibility. Together, these findings support combination-based strategies involving antimicrobial peptides and conventional antibiotics for improving ciprofloxacin activity against resistant clinical E. coli.

Keywords: Antimicrobial peptides; Ciprofloxacin resistance; Combination therapy; Fosfomycin; Efflux modulation; Antimicrobial resistance; Escherichia coli

Synthesis & Characterization of Hydrothermally Processed Chromium Oxide Nanoparticles

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Abstract

Chromium Oxide (Cr2O3) nanoparticles with a wide band gap of approx. 3.4 eV possess good chemical stability, catalytic activity and sensing properties which makes them suitable for applications like coating material, energy storage devices, gas sensors, super capacitor and in recent years widely investigated for its biomedical applications. In the present work, the Cr2O3 nanoparticles are synthesised by a hydrothermal process using Chromium (III) Nitrate nonahydrate, Ammonium Carbonate and Polyethylene Glycol-10000. The hydrothermal method has been employed for synthesis as it offers control over particle size and morphology. Polyethylene glycol (PEG) is a low-cost non-ionic polymer used here as a surfactant and capping agent that regulates nucleation and crystal growth, suppresses particle agglomeration through steric stabilisation, and promotes the formation of nanoparticles with uniform size and controlled morphology. The PEG-assisted precursor was hydrothermally treated at 180℃ for 16h followed by calcination at 400℃ for 2h. XRD analysis was performed to investigate the crystal structure and phase purity. The diffraction pattern confirms the formation of phase-pure rhombohedral Cr2O3 nanoparticles with no detectable secondary phases

Keywords: Chromium oxide, Hydrothermal synthesis, Polyethylene glycol, Capping agent

Novel Protein-nanoencapsulation Platforms, Overcoming The Protein-delivery Challenges for Protein Therapeutic Applications

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Abstract

Introduction: Protein therapeutics, including antibodies, vaccines, enzymes, and hormones, represent a rapidly growing market. However, their clinical use is limited by challenges such as short half-life, instability, immunogenicity, degradation, and dependence on cold-chain storage. Protein-based vaccines, in particular, require strict temperature control to maintain stability. Although nano/micro delivery systems can enhance immunogenicity through co-delivery of adjuvants, current strategies typically address stability and delivery separately. To address these limitations, we propose a Hybrid-Matrix Nanoparticle (HMnP) platform, a nanoencapsulation system that stabilizes proteins during storage and processing while enabling high encapsulation efficiency, controlled release, and targeted delivery through a multifunctional core-shell design.

Aim: To design and optimize HMnPs capable of encapsulating and stabilizing sensitive protein biomolecules, preserving their structural integrity and bioactivity under non-refrigerated conditions, and to evaluate their potential as a versatile platform for vaccine and therapeutic protein delivery.

Materials and Methods: We have developed HMnP system- Sugar glass nanoparticles (SGnPs)-the matrix is composed of sugar and Modified Silk Polymer. Silk fibroin was chemically modified using maleic anhydride to form a stabilizing polymer matrix. For nanoparticle fabrication, a model protein was mixed with trehalose and the modified silk polymer to form a homogeneous suspension. This mixture was introduced into a surfactant-organic solvent system to generate a reverse micelle emulsion, followed by flash freezing, solvent removal, and lyophilization to form sugar glass nanoparticles encapsulating the protein. The nanoparticles were then purified to remove residual surfactants and stored for further use.

Results: Sugar glass nanoparticles showed an average size of 169.8 ± 9.91 nm, increasing to 195.3 ± 7.47 nm after protein (Horsh Radish Peroxidase (HRP)) loading, with low PDI and spherical morphology. The formulation achieved 82% encapsulation efficiency and 96% retained enzymatic activity. High encapsulation efficiency (EE) and activity retention (AR) were also observed for Catalase (81.54% EE; 85.6% AR), LDH (Lactate dehydrogenase) (76.75% EE; 91.57% AR), ALP (Alkaline Phosphtase) (81.71% EE; 99.6% AR), and Papain (72% EE; 84.68% AR) (Fig 1). Spectroscopic and cell studies confirmed structural preservation and excellent biocompatibility (Fig 2). The nanoparticles also showed strong stability, retaining ~100% enzyme activity at 4°C and room temperature and >85% activity at 37- 45°C in dried form.

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Camp1-loaded Albumin Nanoparticles for Sustained Release and Enhanced Cancer Treatment

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Abstract

Camp1, a potent topoisomerase 1 (TOPO1) inhibitor, an analogue of camptothecin and a potent anticancer agent, is derived from naturally occurring camptothecin. Its clinical development has been halted due to dose-limiting toxicities and a shorter plasma half-life in humans. To overcome these challenges, we synthesised a novel Camp1 human serum albumin nanoparticle (Camp1-HSA-NPs) for selective cancer therapy. The Camp1-HSA-NPs exhibited a uniform spherical morphology with an average hydrodynamic diameter of 147 nm, a zeta potential of −24 mV, and a very low polydispersity index (PDI < 0.1). STEM-EDS mapping confirmed homogeneous distribution of Camp1 within the albumin matrix. In vitro release kinetics demonstrated pH-responsive, sustained drug release for up to nine days, with faster release in acidic (tumour-like) conditions. Molecular docking predicted a stable HSA–CAMP1 complex, with a calculated binding affinity of −10 kcal/mol. The complex was predominantly stabilised by hydrogen bonding and hydrophobic interactions. Camp1-HSA-NPs displayed potent cytotoxicity in oral cancer (AW13516) and lung cancer (A549) cells, with significantly reduced toxicity in non-cancerous HEK293T cells. Cellular uptake analysis revealed preferential NPs internalisation in cancer cells (70% in AW13516 and 60% in A549 cells) compared with non-cancerous HEK293T cells (27%), consistent with gp60- and SPARC-mediated albumin uptake mechanisms. Apoptosis assays confirmed selective induction of cancer cell death with minimal impact on normal cells. The Camp1-HSA-NPs exhibited good biodegradability and haemocompatibility, indicating favourable safety and potential for clinical translation. Overall, Camp1-HSA-NPs offer a promising strategy for the sustained, selective tumour delivery of Camp1, with an improved therapeutic index and reduced systemic toxicity.

Keywords: Anticancer, Human serum albumin, Sustained drug release, Selective tumor delivery, cytotoxicity

A Novel 1D/1D HOF-NB@MWCNT-f Nanocomposite via Chitosan-Templated Melamine-Nitrate Self-Assembly: Application in Electrochemical Biosensing of Neurodegenerative Disease Biomarker

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Abstract

One-dimensional nanomaterials, owing to their high surface area and high density of functional groups, are highly attractive as electrode transducer materials for electrochemical biosensors; however, scalable, template-free synthesis remains a significant challenge. Hydrogen-bonded organic frameworks (HOFs) have recently emerged as promising candidates for such electrochemical transducers. Here, we report a novel HOF possessing a distinctive nanobelt morphology, representing the first time a chitosan-directed supramolecular self-assembly of melamine-nitrate complex. The framework was assembled through a template-free aqueous co-crystallisation route, governed by cooperative N-H O and N-H- melamine hydrogen-bonding interactions, with chitosan serving as the structure-directing agent that imparts the one-dimensional morphology. The formation of this HOF was verified using a range of characterization techniques. To enhance electrical conductivity and introduce abundant carboxyl (-COOH) groups for antibody immobilisation, the HOF was integrated with carboxylate-functionalised multiwalled carbon nanotubes (MWCNT-f). The resulting nanocomposite was employed to detect Neurofilament Light Chain (NEFL), a blood-based biomarker associated with neurodegenerative disorders such as Alzheimer's and Parkinson's disease. The fabricated electrochemical biosensor exhibited a linear detection range of 2-1000 pg mL ¹, a limit of detection of 1 pg mL ¹, and a limit of quantification of 1.7 pg mL ¹, with excellent linearity (r^2 = 0.99) and high selectivity against common serum interferents. The sensor also demonstrated excellent recovery for NEFL spiked into artificial serum samples. This work establishes a biopolymer-directed strategy for HOF synthesis and bridges supramolecular framework chemistry with ultrasensitive electrochemical diagnostics for neurodegenerative diseases.

A Point-of-care Pentaplex Nanobiosensor For The Early Triage Of Cardiovascular Disease Using Circulating Epigenomic Signatures

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Abstract

Cardiovascular disease (CVD) is the leading global cause of mortality, accounting for 17.9 million annual deaths, or 32% of all global fatalities. Traditional diagnostic methods rely on downstream necrosis proteins (cTnI, NT-proBNP) that require irreversible myocardial damage to reach detectable levels, critically delaying intervention. Emerging evidence highlights mitochondrial dysfunction as a central catalyst in CVD; oxidative stress triggers the release of mitochondrial DNA (ccf-mtDNA) into the cytosol and bloodstream, inciting profound inflammatory responses. Measuring upstream circulating cell-free nucleic acids (ccf-NAs), including transcriptomic (FOXO3 mRNA, GAS5 lncRNA, miR-34a) and epigenetic (methylated LINE-1 DNA, ccf-mtDNA) markers, offers a vital window into early CVD pathogenesis. Consequently, there is an urgent need to develop rapid point-of-care testing (POCT) biosensors to detect these molecular distress signals before clinical manifestation. The objective of this study was to design, develop, and clinically validate a pentaplex epigenetic fluorescence nanobiosensor for the profiling of these circulating multi-omic biomarkers

Methodology: The fluorospheres were surface-activated via EDC/Sulfo-NHS chemistry and conjugated to streptavidin-complexed biotinylated probes targeting the five biomarkers GAS5 (FS505), miR-34a (FS505-0.2µm), FOXO3 (FS540), mitochondrial DNA (FS580), and 5mc antibody (methylated DNA) (FS660). Signal amplification was achieved using targeted surface intercalation dyes: Propidium Iodide (PI) and SYBR Safe (SS), which were used to capture and confirm detection of RNA and DNA targets. Sensor performance was rigorously validated via fluorescence microscopy colocalization, nanocytometry, and fluorescence intensity measurements, including their applicability, selectivity (against off-targets such as H19 and PVT1), and sensitivity through serial dilutions ranging from 1000 ng to 0.1 fg in 96-well microplate format. The performance of the developed nanoconjugate is validated on a clinical cohort of 385 highly phenotyped individuals (230 active CVD, 155 controls) against conventional ELISA of NT-ProBNP and cTnI. The platform's performance was validated under a regulatory framework: baseline precision and limits of detection (LOD) via ICH Q2(R1) and ISO 11843-2; bioanalytical agreement against gold-standard ELISA using CLSI EP09-A3; and clinical threshold optimization via CLSI EP12-A2. Algorithmic robustness was verified using FDA Software as a Medical Device (SaMD) principle, incorporating Random Forest modelling and 500-iteration bootstrap cross-validation.

Chlorotoxin-functionalized Niosomal Nanomedicine for Enhanced Temozolomide Delivery Across The Blood-brain Barrier in Glioblastoma

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Abstract

Glioblastoma is an aggressive type of cancer that occurs in the brain tissue. In such cases, the treatment is severely limited by the blood-brain barrier through which only a small amount of chemotherapeutic agents can penetrate. For instance, the most common alkylating chemotherapy drug called Temozolomide (TMZ) is characterized by a low bioavailability in the brain area and, thus, requires an enhanced targeted treatment approach..TMZ-loaded niosomes were prepared by the thin-film hydration method. The surface of the niosomes was functionalized with chlorotoxin, which is a 36-amino acid peptide with a high affinity for glioma cells. The formulations were characterized in terms of particle size, entrapment efficiency, and surface modification. In vivo quantitative tissue distribution studies were carried out to evaluate the brain targeting potential of the developed formulations.The optimized chlorotoxin-conjugated niosomes showed a particle size of 220 ± 1.45 nm and an entrapment efficiency of 79.09 ± 1.56%. The quantitative tissue distribution studies demonstrated a 3.04-fold increase in the brain drug concentration as compared to the drug suspension with a reduced amount of drug detected in other tissues.This study provides evidence that chlorotoxin-conjugated niosomes can serve as an innovative nanomedicine platform to deliver TMZ across the BBB and specifically target glioblastoma, which has the potential to significantly improve the prognosis of brain tumor treatment.

Keywords: Temozolomide, Niosomes, Brain Targeting, Chlorotoxin, Glioblastoma, Nanomedicine

Beyond Sensitivity: Nanobiosensors At The Molecular Frontier Of Precision Breast Cancer Detection

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Abstract

Breast cancer continues to be a major health concern worldwide, creating an urgent need for diagnostic approaches that are not only sensitive, but also specific, rapid, minimally invasive, and clinically meaningful. Nanobiosensors have attracted considerable attention in this area because nanomaterials can improve biomolecular recognition and signal generation, enabling the detection of cancer-associated biomarkers at very low concentrations. Recent studies have explored nanobiosensor platforms for biomarkers such as HER2, EGFR, circulating microRNAs, and extracellular vesicle-associated molecular signatures using electrochemical, optical, colorimetric, and electro chemiluminescent strategies.

This poster examines recent advances in nanobiosensor-based breast cancer detection with a particular focus on the gap between analytical performance and clinical relevance. Published studies are compared based on biomarker type, nanomaterial, sensing approach, detection limit, biological sample, multiplexing capability, and level of clinical validation. Greater attention is given to the progression from laboratory-based proof-of-concept studies toward the analysis of clinically relevant and minimally invasive samples, including serum, saliva, sweat, and extracellular vesicles.

The evidence suggests that achieving an exceptionally low detection limit is only one part of successful diagnostic development. Specificity, biological validation, multiplexed detection, sample accessibility, reproducibility, and point-of-care potential are equally important for clinical translation. Overall, this review highlights how nanobiosensors are evolving from highly sensitive molecular detection tools toward integrated platforms with potential to support more accessible and precision-oriented breast cancer diagnosis.

Keywords: Nanobiosensors; Breast Cancer; Cancer Biomarkers; Nanomaterials; Precision Diagnosis; Clinical Translation

Photoacoustic Characterization And Acoustic Vaporisation Study of Gold-coated And Uncoated Perfluorohexane Nanodroplets

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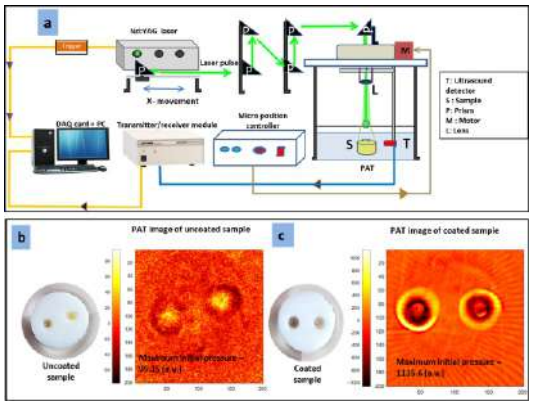
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Abstract

Background, Motivation and Objective : Perfluorocarbon (PFC) nanodroplets have emerged as versatile platforms for drug delivery and externally triggered imaging and therapeutic applications owing to their ability to undergo liquid-to-gas phase transitions in response to ultrasound or optical stimulation. These phase-change agents are being explored for applications including photothermal and sonodynamic therapies. Among PFCs, perfluorohexane (PFH) is particularly attractive because of its relatively high physiological stability compared with lower-boiling PFCs such as perfluoropentane, while its vapour can recondense under suitable conditions, enabling repeated activation. Incorporation of gold nanostructures onto nanodroplet surfaces provides plasmonic optical absorption and photothermal conversion, making them promising agents for photoacoustic applications. This study aims to comparatively investigate the photoacoustic response and acoustic vaporization behaviour of gold-coated and uncoated PFH nanodroplets.

Statement of Contribution/Methods : Gold-coated and uncoated PFH nanodroplets were investigated using multi-angle photoacoustic tomography (PAT) with a custom-built experimental setup (see Fig. (a)). Nanodroplet suspensions (10^10 droplets/mL) in phosphate-buffered saline were embedded in agarose phantoms and irradiated using 532 nm pulsed laser excitation at a fluence of 54.2 mJ/cm². PA signals were acquired using a 5 MHz unfocused ultrasound transducer with 70% fractional bandwidth at 100 uniformly distributed angular positions over 360°. Tomographic images were reconstructed using a time-domain backprojection algorithm, enabling quantitative comparison of the initial photoacoustic pressure. Acoustic droplet vaporization was additionally evaluated using 2 MHz ultrasound excitation with progressively increasing peak negative pressure.

Results/Discussion: The gold-coated PFH nanodroplets exhibited an approximately 12-fold higher initial photoacoustic pressure than the uncoated nanodroplets, with a clearly distinguishable boundary in the reconstructed tomographic images (see Fig. (b-c)). The acoustic vaporization threshold of the PFH nanodroplets was determined to be 3.29 ± 0.93 MPa. These findings demonstrate the influence of gold coating on the optical-acoustic response of PFH nanodroplets and establish their potential as multimodal photoacoustic–ultrasound agents for theranostic applications.



Keywords: Perfluorohexane nanodroplets, Gold-coated nanodroplets, Photocoustic tomography, Acoustics, Therapeutics

Conducting Thread Based Electrochemical Biosensor for Oral Cancer Detection

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Abstract

In this era of innovation, the transition from centralised diagnostics to decentralised diagnostics is on the verge giving rise to various innovative technologies. One of these technologies is flexible wearable electronics. Due to its ability to conform to any surface, miniaturisation and quick response, this technology is optimal for continuous, real-time monitoring of diseases or specific conditions. Thread is a superior example of such electrode substrates because of its cooperative flexibility, excellent mechanical strength and soft integration in smart textiles. Unless made with conductive materials, threads have very low conductivity, and to counter this problem nanomaterials are incorporated in their macrostructure to make them conductive and increase their specific surface area. Here, we have synthesised porous carbon and characterised its structure and topography using X-ray diffraction (XRD), field emission scanning electron microscopy (FE-SEM), attenuated reflectance spectroscopy (ATR) and Raman spectroscopy. The synthesized porous carbon has been incorporated into a poly(3,4-ethylenedioxythiophene): polystyrene sulfonate (PEDOT: PSS) matrix to develop a flexible conductive thread electrode. This electrode is further modified by anti-CYFRA-21-1 monoclonal antibody and bovine serum albumin immobilization. This process of working electrode fabrication is validated again by techniques like FE-SEM, ATR and electrochemical analysis. The electrochemical response of the fabricated biosensing platform recorded by chronoamperometry and results revealed superior sensitivity, lower detection limit and a wide linear range.

Keywords: Porous carbon, thread based electrochemical biosensor, Oral cancer, CYFRA-21-1, Biosensor

Antibacterial Effect of Ciprofloxacin-Conjugated Zinc Oxide Nanoparticles against Multidrug-Resistant *Escherichia coli*

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Abstract

The increasing prevalence of multidrug-resistant (MDR) bacterial pathogens has reduced the effectiveness of conventional antibiotic therapy and necessitates alternative approaches to enhance the efficacy of existing antibiotics. Nanoparticle–antibiotic conjugates have emerged as a promising strategy for improving antibacterial activity against resistant bacterial strains. In the present study, a clinically isolated MDR *Escherichia coli* strain was characterized using antibiotic susceptibility testing (AST) and automated minimum inhibitory concentration (MIC) profiling through the VITEK system. The isolate exhibited resistance to ciprofloxacin and based on the observed resistance, zinc oxide nanoparticles (ZnO NPs) were synthesized and conjugated with ciprofloxacin. The synthesized nanoparticles and ciprofloxacin-conjugated ZnO NPs were characterized using FTIR and UV-vis spectrophotometer and evaluated for their antibacterial activity against the clinical MDR *E. coli* isolate. The antibacterial efficacy of free ciprofloxacin, ZnO NPs and the ciprofloxacin–ZnO nanocomposite was comparatively assessed using MIC assays.

Keywords: MDR *Escherichia coli*; Zinc oxide nanoparticles; Ciprofloxacin; Nanocomposite; Antibiotic resistance; Nanomedicine

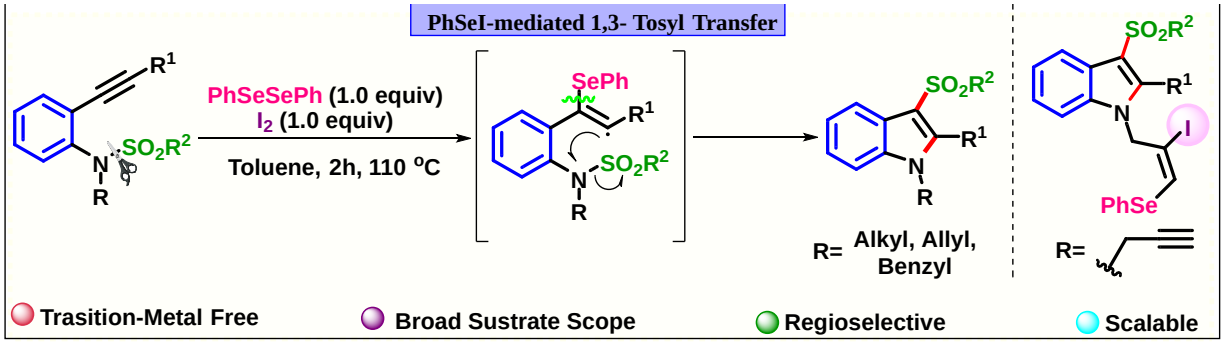
Unveiling a PhSeSePh/I_2-Mediated Radical Cyclisation of 2-Alkynyl-*N*-alkyl-*N*-tosylanilines: Access to 3-Sulfonyl Indoles via 1,3 Tosyl-Relocation

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Abstract

A PhSeSePh/I_2-mediated radical cyclisation of *N,N*-disubstituted *o*-alkynylanilines has been developed, offering an efficient route to 3-sulfonyl indoles through an unprecedented 1,3-tosyl transfer. The transformation commences with a vinyl radical intermediate that undergoes an intramolecular substitution reaction, constructing C–N and C–S bonds in a single step, confirmed by a sequence of control experiments.



Keywords: 1,3-Tosyl Transfer, 3-Sulfonyl Indoles.

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CSIR-Indian Institute of Chemical Biology (CSIR-IICB), Kolkata

The CSIR-Indian Institute of Chemical Biology (CSIR-IICB), Kolkata, is a premier research institute under the Council of Scientific and Industrial Research (CSIR), dedicated to advancing chemical biology and biomedical sciences to address major challenges in human health and disease.

CSIR-IICB has its roots in a nationalistic vision to address India's pressing health problems through indigenous scientific research. It's remarkable journey began in 1935, during the pre-independence period, with the establishment of the Indian Institute of Medical Research by visionary scientists and national leaders. The Institute became part of CSIR in 1956 and was renamed the Indian Institute of Chemical Biology in 1982.

As a pioneering CSIR laboratory with a distinctive mandate in chemical biology, CSIR-IICB brings together expertise in chemistry and biology to address complex biomedical challenges. CSIR-IICB brings together scientists with expertise in Chemistry and Biology who work collaboratively to identify novel therapeutic and diagnostic targets for the treatment of various human diseases.

Today, research is conducted through six major divisions covering Cancer Biology & Inflammatory Disorders, Cell Biology & Physiology, Infectious Diseases & Immunology, Organic & Medicinal Chemistry, Pharmacology & Drug Discovery, and Structural Biology & Bioinformatics. The Institute is supported by advanced facilities, including a Central Instrument Facility, Animal Resource Centre and BSL-2 facilities.

CSIR-IICB is actively pursuing research in CAR-T cell therapy and antimicrobial resistance which poses a major global health threat. Significant research efforts are being directed towards phytopharmaceuticals, drug discovery and design, neurological disorders, Alzheimer's disease detection using brain MRI and deep-learning algorithms, and the Deep Ocean Mission, with an emphasis on converting scientific knowledge into solutions of relevance to human health and society. With an increasing emphasis on translational research, the Institute is strengthening collaborations with hospitals, healthcare institutions, academic organisations and industry to translate promising laboratory discoveries into clinically relevant applications and healthcare solutions.

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Anchored by a legacy of trust, Hindalco is evolving into a solutions-driven company, powering the shift to sustainable, next-generation aluminium and copper applications. Our products and solutions cater to diverse sectors including EV mobility, aerospace, building and construction, renewable energy, pharma and food packaging, high-end electronics, and industrial machinery.

At the core of this evolution is our long-term commitment to sustainability and responsible resource management. Our progress on carbon neutrality, water positivity, biodiversity protection and zero waste to landfill have contributed to Hindalco being recognised as the World's Most Sustainable Aluminium Company by the Dow Jones Sustainability Indices for six consecutive years – 2020 to 2025.

Beyond business, creating value for our communities and enabling people to realise their potential, remains a top priority. Hindalco's CSR initiatives focus on five areas – Education, Health Care, Social Reforms, Sustainable Livelihood, and Infrastructure Development. A Force For Good: our community work enriches 2 million lives across India.

Sharda University

Sharda University, the flagship institution of the Sharda Group, is a leading multidisciplinary university located in Greater Noida, Uttar Pradesh, India. Established in 2009, it has grown into a prominent center for higher education, research, innovation, and entrepreneurship, underpinned by a strong commitment to academic excellence and societal development.

The University is guided by four core values: Integrity, Leadership, Diversity, and Community, which shape an inclusive, ethics-driven educational environment. These values, rooted in principles of social responsibility, are reflected across its academic, research, and community-engagement initiatives.

Sharda University offers undergraduate, postgraduate, doctoral, and professional programs spanning engineering, medicine, pharmacy, law, business, and the humanities, among other disciplines, giving students opportunities to build interdisciplinary knowledge and skills. With students from more than 95 countries, the University sustains a vibrant, multicultural academic community that exposes learners and researchers to diverse global perspectives and prepares them to contribute in an increasingly interconnected world.

Research and innovation are central to Sharda University's academic vision. The University actively promotes research, technological innovation, and interdisciplinary collaboration, encouraging faculty and students to address contemporary challenges across science, healthcare, technology, management, and the humanities. Through its research ecosystem, Sharda seeks to translate knowledge into meaningful societal impact.

The University's vision is "to serve society by being a global University of higher learning in pursuit of academic excellence, innovation, and nurturing entrepreneurship." Its mission rests on four pillars: delivering a transformative educational experience, fostering a global outlook, advancing research & disruptive innovation, and accelerating entrepreneurship through opportunities beyond conventional academic boundaries.

Sharda University holds an A+ grade accreditation from NAAC. It has secured recognition across national and international rankings, including a rank of 87 in the NIRF University category (2025), secured a place in the Times Higher Education World University- Interdisciplinary Science Rankings 2026 in the 601–800 band, and a position of 219 in the QS Asia Rankings. With more than 19,000 students, over 1,200 faculty members, and 13 constituent schools, Sharda University continues to build its reputation for quality education, research, and global engagement.

With its motto, "The World is Here, Where are You? Sharda University represents a dynamic academic community where education, research, diversity, innovation, and global collaboration converge to create opportunities for transformative learning and societal progress.

Immunology Foundation

The Immunology Foundation is a registered non-profit Trust established from the surplus funds of the 10th International Congress of Immunology, held in New Delhi in 1998. Its objective is to promote Immunology and allied sciences by supporting activities constrained by limited resources. The Foundation supports short-term training and inter-laboratory exchange programmes, sponsors workshops and seminars, promotes academia–industry linkages for the translation of research into products, and provides travel bursaries to Indian scientists to enable them to present their work at important international meetings. Prof. G.P. Talwar is its Life-time Managing Trustee.

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Personalized cancer therapy prediction model: Therapy prediction is a challenge in cancer and considering both time and money is critical for cancer management, LifeSenz is working on to develop a patient biopsy derived ex vivo functional 3D cancer model (mimicking in vivo physiology) which can predict therapeutic drug efficacy before the actual clinical treatment begins; thereby it can reduce the effective treatment cost, minimize non-effective treatment-mediated side effects but also improve therapeutic efficacy. At present LifeSenz is initiating the clinical validation study with various channel partners across India and overseas.

Translational Research: LifeSenz currently engaged in both in-house and service based collaborative research programmes on a wider subject area, including cancer, immunology, metabolic diseases, drug discovery & development, nutraceuticals and cosmeceuticals.

LifeSenz exhibits expertise on developing multiple in vitro/ex vivo based disease models (NAMs, mimicking in vivo physiology) to utilize in novel drug discovery and translational R&D across academia and industry.

Scientific Training and Development: Utilizing current laboratory infrastructure, LifeSenz partnering with multiple research-intensive public and private academic institutions to train and upskill biopharma students (under/postgrads/PhD in any stream of Life Sciences) through various short- and long-term research-based, industry-relevant technical training programs. Thereby it is contributing to generating future-ready, high-skilled human resources for global biopharma entities.





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Formulation, Characterisation, Stability

Cell-Based Preclinical Research
- Drug screening, Cell-death Mechanism, Scratch/Wound Healing assays, Migration & Invasion assays to track metastatic inhibition.
- 3D Tumor models: Spheroids & Organoids Molecular & Multi-Omics Profiling

Screening, Mechanism, Safety

Cell-Based Preclinical Research
- Clean range of cosmetics, energised by magnesium.
- Innovation to engineer bio-available, magnesium-based cosmetic therapies that target cellular stress and reinforce epidermal barrier function.

Innovating, Transdermal, Wellness

Partner with us, Validate Faster, Innovate further

One single translational pathway ..... Start to finish!

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The Royal Society of Chemistry

Our mission is to advance excellence in the chemical sciences. This has been at the heart of our work since 1841, when 77 scientists—including doctors, academics, manufacturers and entrepreneurs—formed the Chemical Society of London, with dialysis inventor Thomas Graham as its first President.
Seven years later, Queen Victoria granted the Society a Royal Charter, affirming its purpose: "the general advancement of Chemical Science."

More than 175 years later, that mission remains as relevant as ever. Today, we pursue it on a scale the original 77 members could scarcely have imagined—with more than 60,000 members worldwide, an internationally recognised not-for-profit publishing and knowledge business, and a strong voice championing the chemical sciences.

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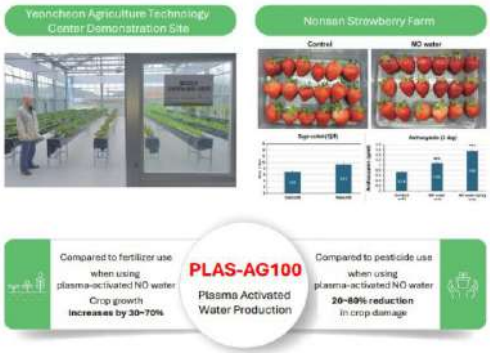
PLASADE







Plasma Nitric Oxide (NO) water for Agriculture, Health and Environment

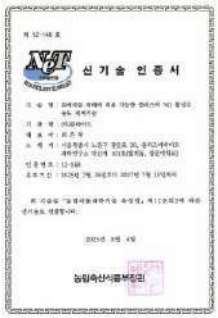


PLAS-AG100

Plasma activated water generator for increasing crop yields and improving pest and disease resistance



Innovation Product Certification



New Excellent Technology Certification

- 6 patents
- 6 Research and Development Certificates
- 6 Certified Test Reports



PLAS-VF100



PLAS-AG50



PLAS-FD100

Application effects of plasma-activated NO water in the agricultural sector



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Semiconductor Sample Preparation

HITACHI

Ion Milling System IM4000 II / ArBlade® 5000

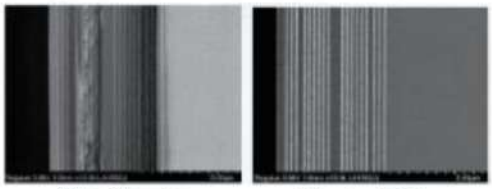
-Solving Cross-Section Preparation Challenges for Accurate Shape Evaluation-

Key features

- Stress-free sample preparation
- Wide-area smooth milling over millimeter-scale regions
- Operator-independent, easy-to-use operation

Smooth Cross-Section Preparation of Multi-Material Samples

By irradiating the sample surface with an ion beam parallel to the cross section, smooth cross sections can be produced even in composite materials consisting of components with different milling rates.

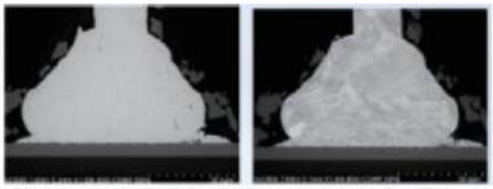


After Cleaving　　After Ion Milling

Sample: IR Cut Filter

Removal of Smearing and Deformation from Mechanical Polishing

Ion milling can be applied as a final finishing process after mechanical polishing. This enables clear grain contrast observation in metallic materials.

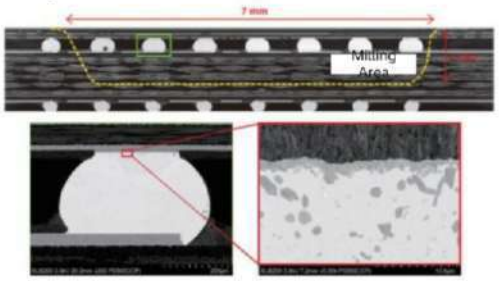


Mechanically Polished　After Mechanically Polished & Ion Milling

Sample: Au Wire Bonding

Wide-Area Smooth Cross-Section Milling

Supports cross-section milling widths of up to 8 mm. This capability is particularly effective for electronic components requiring large-area cross-sectional analysis.



Sample: Electronic Circuit Board

*Wide-area cross-section milling feature available only on ArBlade 5000.

Standard Model IM4000 II　　High-End Model ArBlade 5000



Main Specifications

	IM4000 II	ArBlade 5000
Gas	Argon (Ar)	
Accelerating Voltage	0.0 to 6.0 kV	0.0 to 8.0 kV

Cross-Section Milling

Maximum Milling Rate (Si)	500 µm/h or more *	1 mm/h or more *
Maximum Sample Size for Cross-Section Milling	20(W) × 12(D) × 7(H) mm	

Flat Milling

Maximum Irradiation Area for Flat Milling	Φ32 mm
Maximum Sample Size for Flat Milling	Φ50 × 25(H) mm

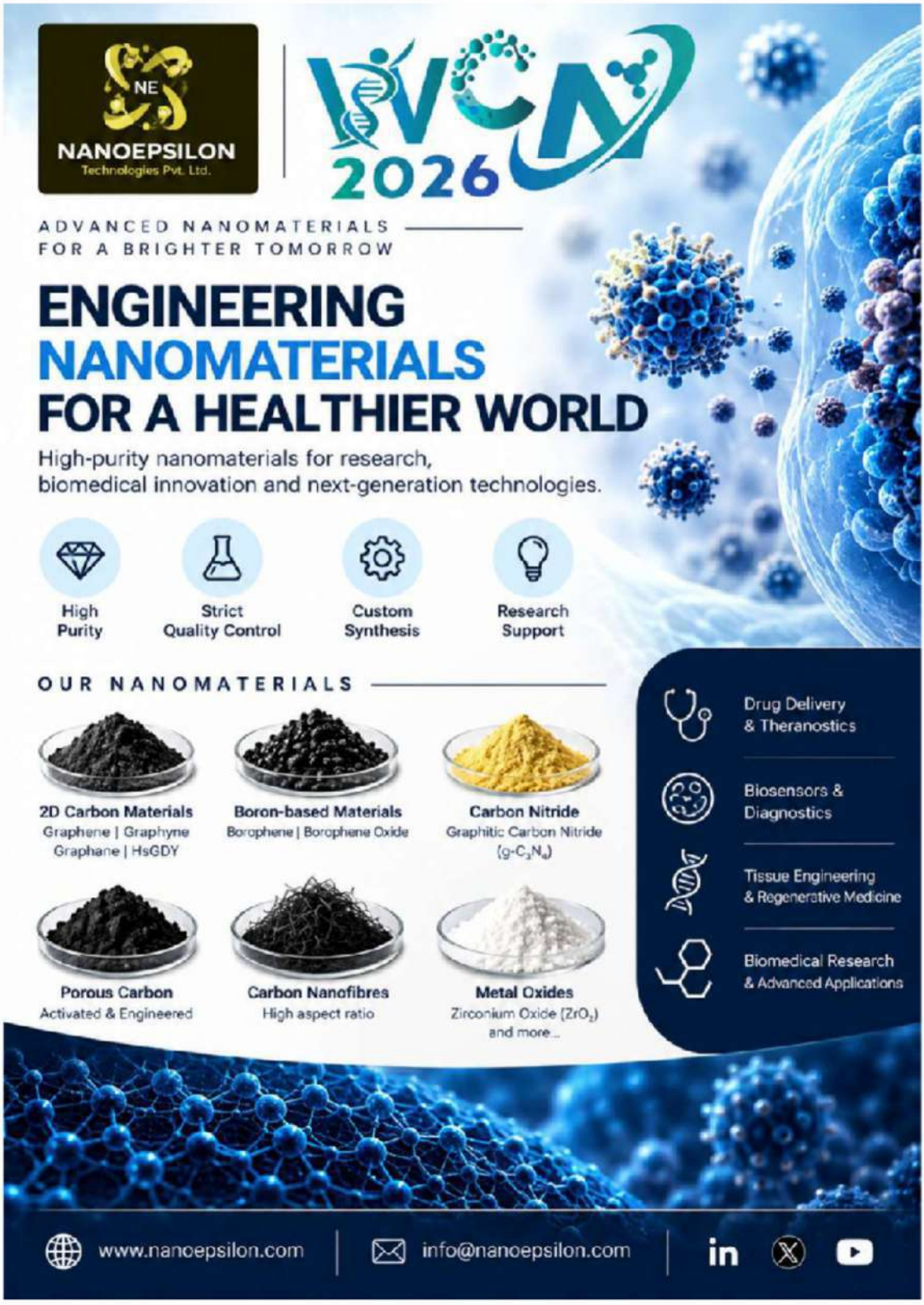
*Measured after 1 hour of milling with a 100 µm Si protrusion from the mask edge.

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The University of Delhi



The University of Delhi is a premier academic institution of eminence which celebrated its centenary year in 2022. As a collegiate university, its main functions are divided between the academic departments of the university and constituent colleges. The university has 16 faculties and 86 departments distributed across its North and South campuses. It has 91 constituent colleges. The undergraduate, postgraduate, doctoral programmes are the instruments of permeation of higher education among the youth, and helped the university attract students from every nook and corner of the country. The numbers have grown to more than 7 lakhs, representing the microcosm of our nation as well as from across the globe.

Widely acknowledged for its innovative and leadership role in the field of higher education, the University of Delhi has produced eminent scientists, top ranking administrators, captains of business and industry and men and women who have enriched the social, cultural and political life of the country. Among the alumni there are illustrious personalities who have gone abroad and made their mark in all walks of life.

Over the last several years the University has become increasingly committed to its participation on projects and academic exchange programmes with global focus. It has entered into overseas agreements with several well-known universities in the USA, U.K., Australia, Europe, Russia, Canada, Japan, China, Ethiopia, Nigeria, Thailand, South Africa and other countries.